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of Mechanical Engineers

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MECHANICAL ENGINEERING

A Journal Unique in its Field — A Journal which Surveys the Field and Reviews for its Readers the World's Technical Periodicals — The Record of a Year.

IN the annual volume of The Engineering Index, just issued by The American Society of Mechanical Engineers, there are over 12,000 items referring to articles in 603 periodicals, comprising the best of the world's technical press in all branches of engineering—civil, mining, mechanical, electrical, etc.

It is significant that of these 603 periodicals 200, or 33 1-3 per cent, treat of the various branches of *mechanical engineering* and the intimately related subject, industrial management. The next largest number devoted to any one branch is in the field of electrical engineering where there are 74 periodicals. There are also 62 general publications, mostly foreign, which contain mechanical engineering articles.

So broad is the field of the mechanical engineer, and so diversified are his interests, that his journals have multiplied and specialized, divided and sub-divided, to a far greater extent than those which cover any other branch of engineering.

The position of MECHANICAL ENGINEERING, the Journal of the A. S. M. E., among this great group of papers, is that of a general publication which not only covers the activities of the Society, but serves as a directory to the multitude of class journals and other technical literature, most of which no engineer has the time nor opportunity to review.

Every engineer needs first of all the class journals in his own special field. Beyond this he needs to know what is being accomplished by other engineers in other fields, and it is the function of MECHANICAL ENGINEERING to supply him with this information.

Now that the Society's meetings for the past season have come to a close and preparations are under way for the fall activities, it will be of interest to review what MECHANICAL ENGINEERING has accomplished during the past year and indicate the extent to which it has fulfilled its objects.

In what follows will be found a selected list of titles of articles which have appeared, grouped under several headings. In addition to these groups of articles The Engineering Index, to which reference has already been made, has been a valued feature for 18 months.

Leading Articles in Mechanical Engineering for the Current 12 Months

Aeronautics. Aeronautic Instruments, Mayo D. Hersey, May, 1920.
Air Fans for Driving Generators on Airplanes, Capt. G. Francis Gray, Lt. John W. Reed and P. N. Elderkin, June, 1919.
Future of Aviation, Col. E. A. Deeds, Jan., 1920.
Physical Basis of Air-Propeller Design, F. W. Caldwell and E. N. Fales, April, 1920.
Rectilinear Flight of Aeroplanes, A. Rateau, May, 1920.

Industrial and Economic. Appraisal and Valuation Methods, David H. Ray, Dec., 1919.
Causes of Industrial Unrest and the Remedy, Frederick P. Fish, Jan., 1920.
Industrial Housing—A Financial Problem, Leslie H. Allen, June, 1920.
Industrial Personnel Relations, Arthur H. Young, July, 1919.
Status of Industrial Relations, L. P. Alford, June, 1919.
Systems for Mutual Control of Industry, William L. Leiserson, Jan., 1920.
Wage Payment, A. L. DeLeeuw, Dec., 1919.
What May We Expect of Profit Sharing in Industry? Ralph E. Heilman, Jan., 1920.

Machine Construction. Certification of Gages at Bureau of Standards, H. L. Van Keuren, Oct., 1919.
Production of Liberty Motor Parts at Ford Plant, W. F. Verner, June, 1919.
Tight-Fitting Threads for Bolts and Nuts, Chester B. Lord, April, 1920.

Machine Design. Centrifugal Compressors, Gustav Fluegel, Oct., 1919.
A Dredging Pump of Novel Construction, W. J. White, Jan., 1920.
Mechanical Lifts—Past and Present, Lieut. J. F. Robbins, June, 1919.
New Type of Hydraulic-Turbine Runner, Forrest Nagler, Dec., 1919.
Perfected High-Pressure Rotary Compressor, Chester B. Lord, Nov., 1919.
Slow-Speed Tests of Kingsbury Thrust Bearings, H. A. S. Howarth, Dec., 1919.
Turbo-Compressor Calculations, Allen H. Blaisdell, March, 1920.

Military. Army Motor-Transport Vehicles, John Younger, Nov., 1919.
First Transcontinental Motor Convoy, Lieut. E. R. Jackson, March, 1920.
German Defenses on the Coast of Belgium, Lt.-Col. H. W. Miller, June, 1920.
German Long-Range Gun, Lt.-Col. H. W. Miller, Feb., 1920.
Refrigeration Requirements of Chemical Warfare, Major A. M. Heritage, Oct., 1919.

Power and Combustion. Central-Station Heating in Detroit, J. H. Walker, June, 1919.
Economy of Arizona Power Plants Using Oil Fuel, C. R. Weymouth, June, 1919.

Power and Combustion (*Continued*).
Emergency Fleet Corporation Water-Tube Boiler for Wood Ships, F. W. Dean and Henry Kreisinger, Dec., 1919.
Locomotive Feedwater Heating, Thomas C. McBride, May, 1920.
Pulverized Coal as a Fuel, N. C. Harrison, Aug., 1919.
Pulverized Coal as a Fuel for Boilers, Edward R. Welles and W. H. Jacobi, Sept., 1919.
Pulverized Coal for Stationary Boilers, Fred'k A. Scheffier and H. G. Barnhurst, Aug., 1919.
Pulverized Coal in Metallurgical Furnaces at High Altitudes, Otis L. McIntyre, April, 1920.
Scientific Development of the Steam Locomotive, John E. Muhlfeld, Nov., 1919.
Separation of Dissolved Gases from Water, J. R. McDermet, May, 1920.
Stoker for Burning Eastern Coals, L. R. Stowe, May, 1920.
Research. Condition of Research in the United States, Arthur M. Greene, Jr., July, 1919.
Industrial Research Laboratory Organization, K. C. Mees, Aug., 1919.
Organization of an Industrial Laboratory, A. D. Little and H. E. Howe, Aug., 1919.
Research Work on Malleable Iron, Enrique Touceda, July, 1919.
Scientific. Dissipation of Heat by Various Surfaces, T. S. Taylor, April, 1920.
Flow of Air Through Small Brass Tubes, T. S. Taylor, June, 1920.
Flow of Water Through Condenser Tubes, William L. De Baufre and Milton C. Stuart, Dec., 1919.
Improved Weir for Gaging in Open Channels, Clemens Herschel, Feb., 1920.
Simplification of Venturi-Meter Calculations, Glenn B. Warren, April, 1920.
Miscellaneous. Fire Engines and Effective Fire Fighting, Charles H. Fox, June, 1919.
Reliability of Materials and Mechanism of Fractures, C. de Freminville, Paris, France, April, 1920.
River Transportation in the Mississippi Valley, E. W. Schadek, May, 1920.

Section Papers Published During the Past Year

Aeronautics. The Horsepower of Resistance in Aeroplane Design, N. L. Lieberman, Sept., 1919. (Buffalo).
Inspection of Airplanes at Romorantin, France. Lieut. Earl E. Ives, Oct., 1919. (Mid-Continent).
Army. The Right Man in the Right Place in the Army, Lt.-Col. John J. Swan, May, 1919. (New York).
Fuels and Power. Fuel Saving in Industrial Plants, John F. Tinsley, Sept., 1919., (Worcester).
The Large Steam Turbine, J. F. Johnson, April, 1919, (Philadelphia).
The Proper Balancing of Fuel, Lubricant and Motor, Wm. F. Parish, March, 1920, (Chicago).
The Tank Car Maintenance Problem, Paul Bateman, Oct., 1919, (Mid-Continent).
Industrial and Economic. The Human Factor in the Operation of Industry, Dr. Henry R. Seager, Nov., 1919, (New York).
Industrial Development in the Trans-Missouri Region, P. F. Walker, Oct., 1919, (Mid-Continent).
Research and Social Evolution, C. F. Hirshfeld, Feb., 1920, (Indianapolis Meeting—Mid-West Sections).
Some Twentieth-Century Problems, William B. Dickson, May, 1919, (Philadelphia).
Machine Shop. Certification of Gages at Bureau of Standards, H. L. Van Keuren, Oct., 1919, (Washington, D. C.).
Electric Arc Welding, F. A. Anderson, May, 1919, (San Francisco).
Gage Limits in Interchangeable Manufacture, E. C. Peck, Oct., 1919, (Washington, D. C.).
Navy. Torpedo-Boat Destroyers in the Making, Commander James Reed, Sept,, 1919. (San Francisco).
Research. The Testing of Farm Tractors, Charles H. Benjamin, Feb., 1920, (Indianapolis Meeting—Mid-West Sections).
A Volumetric Efficiency Test of a Vacuum Pump, George S. Tayman, Oct., 1919, (Mid-Continent).

A Selection of Titles of Articles Which Have Appeared on Public Affairs and Society Interests

Division of Engineering of National Research Council
International Standardization
Enemy Opinion of the Liberty Motor
Report of the A.S.M.E. Committee on Industrial Relations
The Training of Industrial Executives
After-War European Industrial Activtiy
Formulation of Power Test Codes
Recataloging the U. E. S. Library
Life of Andrew Carnegie
The James Watt Centenary
Salaries of Engineers in Canada.
Engineers Honor Eugene Schneider of France
Pan-American Financial Congress
International Electrotechnical Commission
Civil Engineers Discuss Development Problems
First Step Toward Federation of Engineering Societies
Charles Warren Hunt Appointed Secretary Emeritus of the American Society of Civil Engineers
Employees' Representation in Management of Industry
Engineering Foundation Reports Progress in Research
Classification and Compensation of Engineers
National Public Works Department Association Holds Conference in Washington
Autogenous Welding of Boilers and Pressure Vessels
Engineers Honor Memory of John Ericsson
Charles de Freminville Elected to Honorary Membership in the A.S.M.E.
A University for the Industries as Well as for the People
Diesel-Electric Drive for Ships
Recent Developments in American Aeronautics
Major Schroeder's Record Altitude Flight
History of the Students' Army Training Corps
Engineering Organization in India
Proposed National Labor Program
American Engineering Standards Committee Organizing Standardization Work
Herbert C. Hoover Addresses Mining Engineers
The Engineer's Salary and Present Conditions
Government Actvities in Engineering. Alaskan Railroad
Classification of Subordinate Railroad Engineers
Congress Passes General Land Leasing Bill
Congress to Study Reorganization of Federal Executive Departments
Engineer Corps Under the Proposed Army Reorganization
Engineering Council Joins Chamber of Commerce
Engineering Legislation in Congress
Government Aid in Road Building
Important Flood Legislation
Licensing of Engineers
Mail Tunnel Systems for Large Cities
New Board of Surveys and Maps
Patent Legislation
Reclamation Service
Reclassification and Compensation in the Government Service
Road Legislation
Technical Work at Bureau of Standards
War Department Equipment for Trade, Technical Schools and Universities
Water Power Bill Passes Senate
Meetings of Other Societies. American Institute of Electrical Engineers
National Machine Tool Builders' Association
Society of Heating and Ventilating Engineers
National Electric Light Association
Engineering Society of Western Massachusetts
American Society of Civil Engineers
American Society for Testing Materials
American Institute of Mining and Metallurgical Engineers
Society of Automotive Engineers
National Department of Public Works Association
Engineering Institute of Canada
Western Society of Engineers
and many others. A total of 70 reports of meetings of other Societies have been published during the past 12 months.

Important Engineering Survey Articles of the Past Year

Aeronautics. Investigation of Muffling Problem for Aeroplanes, G. B. Upton and V. R. Gage (*Natl. Advis. Comm. Aeronautics*), April, 1920.

Maintaining Constant Pressure Before Carburetors of Aero Engines Regardless of Their Altitude, L. V. Spencer (*Aerial Age Weekly*), July, 1919.

Napier Lion Aircraft Engine (*Automobile Engr.*), Oct., 1919.

Tarrant Triplane (*The Engineer*), July, 1919.

Engineering Materials. Corrosion of Condenser Tubes (*The Engineer*), May, 1920.

Effect of Corrosion on Wrought Manganese Bronze under Tensile Stress, P. D. Merica and R. W. Woodward (*American Machinist*), Sept., 1919.

Fatigue of Metals under Repeated Stress, H. F. Moore (*Jl. Western Soc. Engrs.*), March, 1920.

Strength and Other Properties of Wire Rope, J. H. Griffith and J. G. Bragg (*Technologic Paper no.* 121, *Bur. Standards*), July, 1919.

Fuels and Firing. Alcohol Fuel Committee's Report (*Motor Traction*), Aug., 1919.

Low-Temperature Distillation of Coal, C. M. Garland (*Power*), Oct., 1919

Low-Temperature Distillation of Sub-Bituminous Coal, H. K. Benson and R. E. Canfield (*Jour. Ind. and Eng. Chem.*), June, 1920.

Gas Turbines. Develop. of Holzwarth Gas Turbine Since 1914, Hans Holzwarth (*Zt. Ver. deut. Ingenieure*), April, 1920.

Hoisting Machinery. Shipyard Crane, W. H. Hok (*Marine Engrg. and Can. Merchant Service Guild Review*), May, 1920.

Hydraulic Engineering. Comprehensive Plotting of Water Turbine Characteristics, K. R. Kennison (*Proc. Am. Soc. Civil Engineers*), Oct., 1919.

Determination Velocity of Flow of Liquids, C. Camichel (*Revue Générale de l'Electricite*), Jan., 1920.

Hexagonal Chart for Finding Velocity of Water in Pipes, C. W. Anthony (*Engineering News-Record*), Sept., 1919.

Italian Water Turbines, N. Davey (*The Engineer*), Jan., 1920.

Orifice as Means of Measuring Flow of Water Through a Pipe, R. E. Davis and H. H. Jordan (*Univ. Ill. Bull.*), Dec., 1919.

Seewer Governor for High-Head Hydraulic Turbines of Pelton Type, A. Strickler (*Bull. Technique de la Suisse Romande*), Nov., 1919.

Surge Pressures in Pipe Lines, R. Bennett (*Engineering News-Record*), July, 1919.

Hydraulic Machinery. Balanced Hydraulic Valve (*Engineering*), April, 1920.

Determination of Energy Losses in Centrifugal Machinery on Basis of Their Characteristic Curves, R. Muller (*Zt. des Ver. deut. Ingenieure*), Dec., 1920.

Internal-Combustion Engineering. Practical Brake-Horsepower Formula for Internal-Combustion Engines, H. Lemp (*Gen. Elec. Review*), May, 1920.

Valve Failures and Valve Steels of Internal Combustion Engines, L. Aichison (*Automobile Engr.*), Jan., 1920.

Fuels for Aircraft Engines (*Natl. Advis. Comm. Aeronautics*), March, 1920.

Liberty Motor, O. Schwager (*Der Motorwagen*), Aug., 1919.

Tosi Diesel Engines for Submarines (*Engineering*), Aug., 1919.

Doxford Oil Engine (*The Engineer*), Sept., 1919.

Effect of Neutral Gases on Temperature of Working Fluid in an Internal-Combustion Engine, K. Takemura (*Jl. Soc. of Mechanical Engrs., Tokyo*), Sept., 1919.

Investigation of Airplane Fuels, E. W. Dean and C. Netzen (*Jl. Soc. of Automotive Engrs.*), Sept., 1919.

Sanders Pressure Turbine (*Jl. Soc. Automotive Engrs.*), Nov., 1919.

Lubricants. Oiliness of Lubricants (*Engineering*), Feb., 1920.

Theory of Practice of Lubrication: The "Germ" Process (*Jour. Soc. Chem. Industry*), May, 1920.

Machine Elements. Ball and Roller Bearings, Capt. J. B. Swan (*Automobile Engineer*), Sept., 1919.

High Speed Turbine Gears, G. Stoney (*Engineering*), Jan., 1920.

Mechanical Reduction Gears in Warships, Engr.-Comm. Tostevin (*Engineering*), May, 1920.

Machine Shop. Cutting Power of Lathe Turning Tools, Geo. W. Burley (*Jl. Instn. Mech. Engrs.*), Feb., 1920.

Pots and Boxes Used for Carbonizing, H. H. Harris (*Iron Age*), April, 1920.

Tolerances in Mechanical Construction (*Le Genie Civil*), July, 1919.

Machine Tools. Crankshaft Lathe, E. Viall (*American Machinist*), Oct., 1919.

Foote-Burt "Way" Drilling Machines, J. V. Hunter (*American Machinist*), June, 1920.

Relieving Attachment for Lathes (*Engineering*), April, 1920.

Management. Fatigue and Its Effect on Production, A. Vautrain (*Tecknik und Wirtshaft*), June, 1920.

Marine Engineering. British Battle Cruiser "Hood" (*Engineering*), May, 1920.

Turbine Gear Drive for Torpedo-Boat Destroyers, W. B. Flanders (*Electric Jl.*), May, 1920.

Mechanics. Influence of Various Factors on Rise of Longitudinal Internal Stresses Due to Rapid Cooling of Steel Cylinders, M. Portevin (*Comptes Rendus hebd. des Seances de l'Académie des Sciences*), Feb., 1920.

Stability of Long Struts of Variable Section, Prof. A. Ono (*Memoirs Coll. of Engineering, Kyushu Imperial Univ.*), Feb., 1920.

Metallurgy. Occlusion of Gases by Metals (*Trans. Faraday Soc.*), Dec., 1919.

Motor-Car Engineering. Producer Gas for Motor Vehicles, D. J. Smith, March, 1920.

Physics. Arrangement of Electrons in Atoms and Molecules, I. Langmuir (*General Elec. Review*), Sept., 1919.

Power Plants. Calculation of Dimensions and Conditions of Operation of Surface Condensers with Air Leakage, K. Hoefer (*Zt. des Ver. deut. Ingenieure*), Dec., 1919.

Pneumatic Steam Turbine Governor (*Power*), Oct., 1919.

Present Limits of Speed and Power of Single Shaft Steam Turbines and Turbo-Generators (*Proc. Am. Inst. Elec. Engrs.*), Jan., 1920.

Power Transmission. Standardization of Power Plants, L. R. Lee (*Power*), April, 1920.

Power Transmission by Sonic Waves, J. Herck (*Bull. Technique du Bur. Veritas*), May, 1920.

Pumps. Water Pumps of the Drainage Station at Codigoro (*Schweizerische Bauzeitung*), Oct., 1919.

Railroad Engineering. Last Stand of Reciprocating Engine, A. H. Armstrong (*Jl. Am. Inst. Elec. Engrs.*), June, 1920.

Wind Resistance on a Train, C. F. Dendy Marshall (*Railway Mechanic Eng.*), Aug., 1919.

Refrigeration. Design of CO_2 Machines, John E. Starr (*Refrig. World*), Sept., 1919.

Salt Precipitation by Refrigeration, B. Block (*Zt. f. d. gesamte Kalte-Industrie*), Feb., 1920.

Scientific Problems of Cold-Storage Industries, W. B. Hardy (*Cold Storage and Ice Assoc.*), May, 1920.

Test of a 2-ton Clothel Refrigerating Machine, M. C. Stuart (*Jl. Am. Soc. Naval Engrs.*), Nov., 1919.

Quincy Market Cold Storage Plant at Boston, Chas. H. Bromley (*Power*), Jan., 1920.

Safety Engineering. Spontaneous Combustion, W. Smith (*Jl. Royal Soc. Arts*), Aug., 1919.

Steam Engineering. Bucket Efficiency of Impulse and Reaction Steam Turbines, Prof. Tore G. E. Lindmark (*Teknisk Tidskrift Mekanik*), July, 1919.

Determination of Efficiency of Turbo-Alternator, S. F. Barclay and S. P. Smith (*Jl. Instn. Elec. Engrs.*), Aug., 1919.

Employment of Nozzles Instead of Cylinders or Wheels in Turbines, Prof. R. Mollier (*Zt. Ver. deut. Ing.*), Feb., 1920.

Testing and Measuring. Method of Reaching Extreme Altitudes, R. H. Goddard (*Smithsonian Misc. Collections*), March, 1920.

Thermodynamics. New Thermodynamic Cycle, Wm. J. Walker (*Engineering*), May, 1920.

Theory of Equilibrium Conditions in Saturated Steam, H. H. Martin (*Engineering*), Dec., 1919.

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MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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An Experimental Investigation of Steel Belting

Particulars Regarding Belt Material and the Joints Used—Description of Apparatus Employed in Tests—Determination of Relationships Existing Between Horsepower Transmitted, Velocity of Slip on Pulleys, and Coefficient of Friction

By F. G. HAMPTON, C. F. LEH, AND W. E. HELMICK, STANFORD UNIVERSITY, CAL.

At the Annual Meeting of The American Society of Mechanical Engineers, held December 2 to 5, 1919, in New York, Student and Junior prizes were awarded to the authors of the following paper. It treats of an investigation undertaken by them at Leland Stanford University as a partial requirement for the degree of engineer. Part I was written by Messrs. Hampton and Leh in 1918, and Part II by W. E. Helmick the year following. The first section deals with a description of the apparatus employed, the character of the belting, and a discussion of the results obtained in investigating the coefficients of friction and velocity of slip. Part II deals more particularly with the slip of the belting, which the original investigators recognized should be more carefully studied.

PART I GENERAL INVESTIGATIONS

ATTENTION has been called from time to time to the successful use of thin ribbons of steel for belting, and the purpose of the experimental work herein described was to determine as far as time would permit the characteristics of operation and the general laws controlling the performance of this means of power transmission. The literature on the subject of steel belts is very limited, and so far as is known there has been little or no experimental work done.

The controlling features of the design of an apparatus for testing steel belting may be enumerated as follows:

1 The machine must be so constructed that very high speeds may be obtained, and also means provided to vary the speed over as large a range as possible

2 Since very high efficiencies are expected, it is necessary to provide means for measuring, as accurately as possible, the losses of power which occur in the belt

3 The apparatus must be so constructed that the tensions in the tight and loose side may be accurately determined

4 On account of the relatively small slip it is necessary to provide specially constructed apparatus to accurately determine this variable

5 For the sake of convenience it is necessary to have the machine built so that belts can be changed easily and different lengths used.

Description of Apparatus

Two special high-speed pulleys were constructed upon which the belt to be tested was run. Since the speed at which cast iron can be safely run is far below that which was desired, it was necessary to select a stronger material and so construct the pulleys that they could be faced with some other material than steel.

The pulleys used were built in the department shops by the authors and consisted of two boiler-plate disks, a cast-iron hub, and a wooden rim. The pulleys were made relatively large in order that high peripheral speeds could be obtained with relatively low shaft speeds. The facing consisted of sheet cork, which was chosen as the best material on account of the friction properties and its durability.

One of these pulleys, which was to be the driven pulley of the machine, was keyed directly to the shaft of a 100-hp. Sprague dynamometer (see Fig. 1), which was used in testing only as a means of absorbing the power delivered to the driven pulley, and, although record was kept of the readings of the dynamometer, they were only used as a check and did not enter into the calculations of the test.

The other pulley, the driver, was mounted on a short countershaft held in two bronze bearings which were cast and finished specially for the purpose, the bearings being held in a pair of standard shaft hangers which were bolted to the frame. This shaft carried the driver pulley on one end, and on the other end the pulley with which the shaft was driven by a motor through a leather belt.

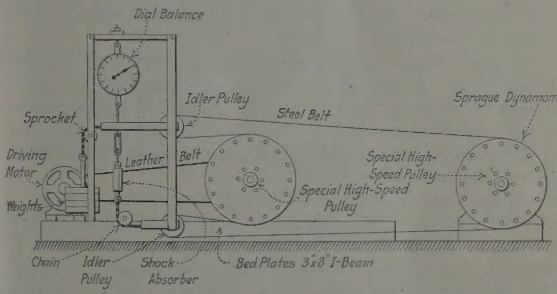

FIG. 1 DIAGRAMMATIC SKETCH OF STEEL-BELT TESTING MACHINE

In order to measure the tensions in both sides of the steel belt, two special idlers were hung behind the driver in such a way that each one completely reversed the direction of the belt on both the tight and loose sides between the driver and the driven pulleys.

In the original design of the machine the straight sections of the belt were all to be kept parallel by using a small driver, a large driven pulley and idlers of such size that the sum of the diameters of the driver and two idlers would be equal to the diameter of the driven pulley. This arrangement was discarded because of the work which would have been necessary on the available apparatus and the belts were run with their straight sections at an angle. The manner in which this angularity was corrected for will be discussed later.

The idler pulleys were hung on swinging frames so that they were free to swing in the plane of middle of the driver and driven pulleys' faces, but were constrained from moving in any other direction. They were carried on short shafts with high-grade ball bearings in order that friction would be reduced to a minimum.

The design of these pulleys was also controlled by the high speed at which they were expected to run, and it was necessary to use a stronger material than cast iron.

Castings were made which formed the hub and a thin, solid web, and rims were made by cutting sections from a piece of heavy lap-welded 10-in. pipe. The castings and steel rings were finished all over, the proper allowance being made for a shrink fit, and the rims heated and shrunk on to the webs, after which they were again machined all over and accurately balanced.

Since it was not considered desirable that the steel belt come in contact with the steel surface of the idlers, even though slippage at this point would be very improbable, the pulley faces were covered with the same variety of sheet cork that was put on the large pulleys.

Throughout the test no trouble was encountered with the cork faces of either the idler pulleys or the large pulleys, and, although speeds as high as 12,000 ft. per min. were attained, there seemed to be no tendency for the cork to fly off.

In order that the pull exerted by the belt on the idlers could be accurately measured, yokes were put on the idler shafts around the idlers, and to these were attached link chains which passed horizontally over ball-bearing sprockets so that, when the swinging frames were in their normal position, the chains were tangent to the arc of their swing and in the same plane. The chain from the idler, over which the tight side of the belt passed, hung vertically downward after passing over its sprocket, and on it was suspended a stem with a plate on its lower end and upon which weights could be placed. The chain from the other idler extended vertically upward after passing over its sprocket, and was attached to the lower part of a dial balance which measured the pull on the loose-side idler.

After starting the test it was found necessary to introduce some kind of a shock absorber to reduce the vibration of the needle on the dial balance, and for this purpose a spring balance of 200 lb. capacity was used. It was also necessary to adjust the length of this chain on account of the variations arising from difference in tension, and to do this a turnbuckle was put in between the dial and spring balances.

The swinging frames, guides, sprockets, and the dial balance were all carried on a rigid superstructure composed of iron bars and angles, and this was firmly bolted to the same I-beams which carried the shaft hangers holding the countershaft, and also the driving motor, so that there could be no relative movement between the various parts of the assembly.

The bedplates which supported this unit consisted of two 8-in. I-beams 16 ft. long, which were set at right angles to the shaft of the Sprague dynamometer and firmly bolted to the floor and shimmed with neat cement. These bedplates formed a guide upon which the driver unit was supported so that this part of the apparatus could be easily moved along the bedplate to accommodate belts of various lengths and without having to disturb the relations between the several elements of the unit.

The motor which was used to supply the driving power was a variable-speed, three-phase induction motor with speeds of 600, 900, 1200, and 1800 r.p.m., and rated at 4, 6, 8, and 12 hp. for these respective speeds. The motor was mounted on an adjustable base so that the leather belt driving the countershaft could be tightened, and the controller was mounted on the sliding frame near the motor.

The motor, which is of the most desirable type for the purpose, was not nearly large enough, and as a consequence the range of experimentation was limited by the available power supply and not by the transmission properties of the steel belt as it should have been.

Since it was necessary to make as accurate a determination as possible of the slip which occurred in the belt at all times, two similar devices were made which would electrically control two speed counters, one mounted on the center of the driver shaft and the other on the driven shaft. Two Veeder revolution counters were used for this purpose, being fixed to the shafts so that their spindles rotated on the same centers as that of the shaft; the remainder of the counter floating on the spindle and remaining stationary. On the stationary part was suspended a bar which carried an electromagnet so arranged that when current passed through the coils the movement of the armature would actuate a small lever, which slid the floating part of the counter axially so as to engage the dog clutch and count the revolutions of the spindle. Springs returned the counter to the original position and disengaged the clutch when the circuit was opened.

This arrangement gave a fairly accurate measure of speed because both instruments were made alike; and since the coils were in the same circuit and the springs of the same strength, it should give very dependable results. The difficulty, however, was not in the determination of the absolute speed, but of the difference of speed, and, since the counters only registered to the nearest revolutions and the clutches were only two-jaw clutches, there is a possibility and also a probability of an error of one revolution either way, or two revolutions, and when the slip is small, say, only 2 r.p.m., may involve an error in slip of 100 per cent, although the error involved in determining absolute speed is only a very small fraction of one per cent. In order to make accurate measurements of slip, it is evident that a differential counter should be used of such design that it would record to at least 0.10 r.p.m.

The entire testing apparatus as herein described is in itself a transmission dynamometer which measures its own losses. Having measured the tension in both the tight and the loose sides of the steel belt, and the peripheral velocity of both driving and driven pulley, the power delivered to the driving end of the belt may be computed from the value of the net pull, which is the difference between the two belt tensions and the peripheral speed of the pulley face. In a similar manner the power delivered to the driven pulley may be computed from the net pull and the peripheral velocity, the tension in the belt being uniform between pulleys, and the friction or slippage losses may be obtained from the net pull and the velocity of slip.

It is assumed that no work is done or power consumed in bending the belt, and this assumption is substantiated by the fact that the material is perfectly elastic within the limits worked, and whatever power is required to bend the belt is given back to the system when it returns to its normal condition.

In order to further verify this assumption, pieces of the belting were caused to vibrate at a very high rate of speed by holding them on the teeth of a rapidly turning sprocket. Had there been any appreciable internal friction losses present there would have been a noticeable rise in temperature in the part of the steel which was subjected to such rapid bending. Although the pieces became warm at one end from the friction of contact with the sprocket, and on the other end from impact on the material with which they were held, the part which was subjected to the severest bending remained cool.

This leaves the only losses sustained in transmitting power by steel belting to be those due to slippage of the belt on the cork surface, and since this can be reduced to practically nothing by increasing the belt tension, it appears that practically 100 per cent transmission efficiency may be obtained. The experimental results consistently verify this statement.

BELT MATERIAL AND CORRECTION FOR ANGULARITY

The material which was used for the steel belts in this work was what is known in the commercial world as clock spring. It is very high-carbon steel drawn and rolled, apparently ground to size, hardened, and drawn to a dark-blue color. A rough test showed a tensile strength of slightly over 300,000 lb. per sq. in. and an elastic limit nearly as high. The material in pieces 0.01 in. thick receives no permanent set when bent around a radius of ½ in. and snaps with a clean break when bent around a radius of $\frac{1}{16}$ in.

The chief difficulty in using such material for belting is to get a joint which will develop a sufficient proportion of the strength of the material. Considerable work was done in this connection, and, although no prediction of the durability of the joints used can be made, on account of the short duration of the test, they proved to be entirely satisfactory within the limits used, and under conditions which were probably much more severe than would be found in an actual commercial installation.

Because of the arrangement of the pulleys, and the consequent reversal of the curvature which any part of the belt receives when passing over them, it was impossible to use the standard fastening, which consisted of a strap of a curvature equal to the smallest pulley and to which the two ends of the belt were made fast by means of screws or rivets. A later discussion of the subject of joints will describe the various ones used and show why the plain butted joint held with silver solder was the best one for the purpose.

In order to correct for the angularity of belt pull on the idler pulleys and its effect upon the readings of the dial balance and the dead weights, a method was used which calibrated the exact belt tension directly against the readings of both the dial balance and the dead weights.

A belt was put on which, instead of being spliced, had its two ends joined by a link composed of a turnbuckle and an accurate spring balance. Weights were put on the hanging platform, the swinging arms brought to their normal positions by adjusting the turnbuckle below the dial balance, and readings were taken of the dial balance and the spring balance while slowly rotating the driven wheel first in one direction and then in the other. This method divided the friction, and the average of the two readings gave the true readings which could be plotted against one another and a curve drawn from which the true belt tension could be read for any reading of the dial balance or the dead weights.

DESCRIPTION OF TESTS

On account of the limited time it was only possible to cover a small portion of the work necessary for a complete test of steel belting, and accordingly the field in which speed, horsepower, and tension are the chief variables was selected for investigation.

A series of runs was made at constant speed and, keeping one value of tension at a constant value, the load was varied from no load to an upper value limited either by the available supply of driving power or by the slippage in the steel belt.

Since the tension in the tight side, T_1, was kept constant over any run, it may readily be seen that for an increase in transmitted horsepower the factor $T_1 - T_2$ could be made larger only by decreasing T_2, and that when this quantity was reduced to a very small value the loose side of the belt would become very unstable. After covering the range of horsepower possible, the tension was changed and another run made with varying horsepower.

Having covered the desirable range of tensions, the speed was then changed and another series of runs at the new speed was made. In making a run, the apparatus was adjusted to operate under conditions of practically no load, the swinging frames on the idlers were brought into their normal position by adjusting the turnbuckles and readings were taken of r.p.m. of driver and driven pulleys, the dial balance indicating the tension in the loose side and the dead weights the tension in the tight side. In timing the r.p.m., 2-min. intervals were used in order to reduce the error due to starting and stopping the counters.

The instruments indicating the other readings were found to be exceptionally constant, and since each reading was checked by both the parties making the run, only one reading for the most part was entered on the log sheets. By taking readings of the Sprague dynamometer beam, data were made available for a calibration of this machine at low capacity values and which also served as a rough check on the other readings.

An accurate calibration was made of all the instruments used on the test, including the two spring balances, stop watch, and dead weights. The readings taken can be depended upon to have a high degree of accuracy, with the exception of the difference of r.p.m. in driver and driven pulleys. Since this is a very small value and the error involved is in starting and stopping the counters, the percentage of error in the indication of absolute speed is practically zero.

Since the readings of the tight-side tension were made with weights, they are as accurate as the weights. No difficulty was encountered in reading the dial balance to the nearest pound, and since the idlers were adjusted to their normal position for every change, the readings relative to the belt tensions should be accurate to within one per cent.

The arc of contact was measured for each belt length used. As can be seen, when the distance between centers of driver and driven pulleys is varied there will be a slight change in the arc of contact. Since this change was so small and was used only in connection with the value of slip which as explained before had a large percentage of error, the change in the arc of contact was not considered.

The following will show how the various values used were obtained from the results of the tests:

Revolutions per Minute. The difference in the readings of the positive speed counters at the beginning and at the end of the timed interval will give the r.p.m. of the driver and driven pulleys, while the difference between the values thus obtained will give the r.p.m. slip.

V_s On account of a slight difference in the circumference of the driver and driven pulleys, it was necessary to make a correction. This was made by constructing a diagram from which the velocity of slip could be read directly for any r.p.m. slip and any speed.

V_d The driver velocity is obtained by multiplying the driver r.p.m. by its circumference.

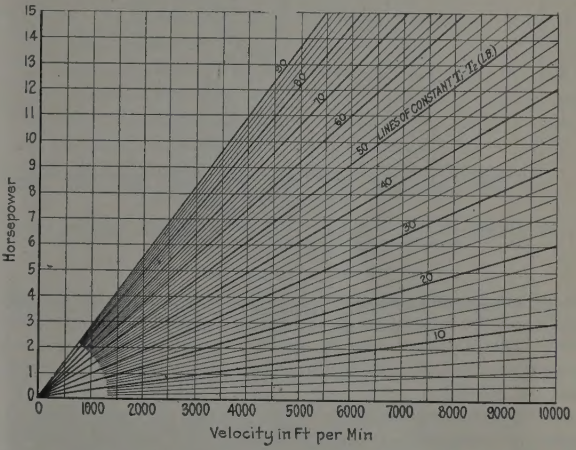

FIG. 2 DIAGRAM FOR COMPUTING HORSEPOWER FROM VELOCITY AND DIFFERENCE IN TENSION

T_1 The tension in the tight side of the belt is read directly from a calibration curve.

T_2 The tension in the loose side is also read directly from a calibration curve.

t_1 The unit tension in the tight side is found by dividing T_1 by the cross-sectional area of the belt, or

$$T_1/0.01 \times 0.75 = T_1/0.0075$$

Driver Hp. was obtained from the relation:

$$\text{Hp.} = \frac{\text{force} \times \text{distance moved per min.}}{33{,}000} = \frac{(T_1 - T_2)\,V_d}{33{,}000}$$

A chart was made (Fig. 2) from which the horsepower at any speed or any value of $T_1 - T_2$ may be read directly. This was done by plotting the lines Hp. $= KV_d$ for values of K corresponding to the required values of $T_1 - T_2$.

Hp. Loss. This can be obtained from Fig. 2 by using V_s in place of V_d and dividing both horizontal and vertical scales by the same power of ten.

Efficiency is computed by taking the ratio of the power input to the belt to its power output:

$$\frac{\text{Hp. driver} - \text{Hp. loss}}{\text{Hp. driver}}$$

t_c The centrifugal tension is determined from the relation:

$$t_c = \frac{WV^2}{g}$$

Fig. 3 shows a plot of this using the proper units and from which t_c for any belt speed may be read.

u The value of the coefficient of friction was calculated from the relation:

$$\log \frac{t_1 - t_c}{t_2 - t_c} = 0.4343\, u\theta$$

where u = coefficient of friction
θ = angle of contact in radians.

DISCUSSION OF RESULTS

On account of the uncertainty of the test values of V_s it was first necessary to find, if possible, how this value varied with the others and to discover the law which connected its variation with that of other quantities involved. The first step in this process was to plot the test values of V_s against the corresponding values of hp. This was done over the whole range of the test, one sheet for each constant, T_1. Table 1 and Fig. 4 show results and curves for $T_1 = 100$ lb.

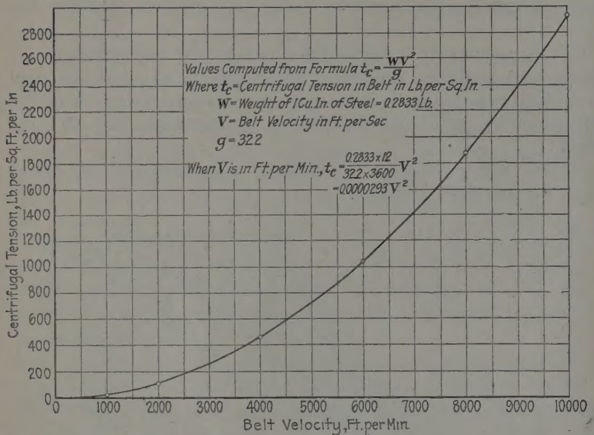

FIG. 3 CURVE OF CENTRIFUGAL TENSION FOR BELT SPEEDS UP TO 10,000 FT. PER MIN.

After careful consideration of the location of these points, it seemed that the curves for all speeds for any T_1 seemed to follow a straight line beginning at the origin and then to break sharply and leave this line, the point of departure depending upon the speed, and being different for different values of T_1.

It was also noticed that for high values of T_1 the straight line from the origin was much steeper than for lower values. Working on this assumption straight lines were drawn which represented the mean of all points which seemed to locate the line. Although there is a wide variation in the location of these points, it must be remembered that the percentage of possible error in the value of V_s is very large, in fact large enough to justify the moving of practically any of the points to the mean line.

Since it was evident that some simple law existed between the various curves, as shown by the change in slope of the main straight line from the origin for different values of tension, values of V_s were plotted against their corresponding values of tension, at constant horsepower. This was done by taking the values of V_s from each curve at 10 hp. and plotting them against the value of tension corresponding to the curve.

The relation as shown from the plot proved to be a very close approximation to a straight line and accordingly the line was assumed and the lines previously located to represent the mean of the plotted points were so changed as to make their inclination to the hp. axis conform to the law. This correction was considered desirable and even necessary on account of the uncertainty in the values of V_s, which has been discussed before.

Data were now available for the construction of a characteristic diagram in which lines of constant hp. were laid down on V_s and T_1 axes. (See Fig. 5.) It was noticed on the hp.-V_s curves that there seemed to be some symmetrical relation between the points at which the curves for different speeds broke away from the characteristic straight line. Accordingly all of these points were transferred to the V_s and T_1 diagrams, the result being a series of surprisingly well-defined lines radiating from very near the origin and cutting the lines of constant hp.

TABLE 1 DATA AND RESULTS OF TESTS ON 0.75 x 0.01-IN. STEEL BELT
(T_1 = 100 lb.)

No. Run	R.p.m. Driver	R.p.m. Driven	Slip ft. per min.	V_d ft. per min.	T_2 lb.	Hp. Driver	Hp. Loss	Eff., per cent	u	V_{sc}
21	243	242	4	2075	46	0.16	0.0002	99.9	0.023	0.1
	242	240	4	2055	34	0.90	0.0008	99.9	0.122	0.8
	240	239	4	2048	19	1.82	0.0031	99.8	0.317	1.7
	238	217	176	2032	3.5	2.64	0.1200	81.4	....	44.0
16	364	363	4	3110	46	0.235	0.0001	99.9	0.0246	0.3
	363	361	4	3090	33.5	1.41	0.0013	99.8	0.127	1.4
	360	359	4	3080	20.5	2.61	0.0043	99.7	0.303	2.5
	358	357	4	3060	12.5	3.32	0.0065	89.6	....	3.0
	357	295	493	3050	0.5	4.41	0.7200	83.5	....	246.5
13	485	484	0	4140	45.5	0.38	0.0001	99.9	0.097	0.4
	480	479	0	4100	32.5	1.97	0.0022	99.9	0.136	2.3
	476	472	0	4060	20.0	3.50	0.0057	99.8	0.322	3.1
	466	410	473	3990	0.0	5.85	0.7000	88.8	....	227.0
1	727	725	5	6210	36.2	2.31	0.0010	99.9	0.118	2.1
	723	721	5	6180	28.5	3.75	0.0035	99.9	0.223	3.5
	715	711	22	6110	14.5	6.30	0.0089	99.9	0.601	5.8
	709	701	57	6060	7.2	7.58	0.0706	99.1	....	10.0
	702	656	358	6060	2.5	8.37	0.4990	94.1	....	179.0
	698	607	729	6060	1.7	8.45	1.0300	87.9	....	365.0
33	1102	1099	8	9400	33.0	4.31	0.0033	99.9	0.231	3.7
	1065	1062	8	9085	21.5	7.41	0.0105	99.8	0.690	6.5
	1050	1047	9	8905	13.5	9.47	0.0170	99.8	....	8.5
	972	939	265	8205	2.5	11.44	0.0570	96.7	....	128.0

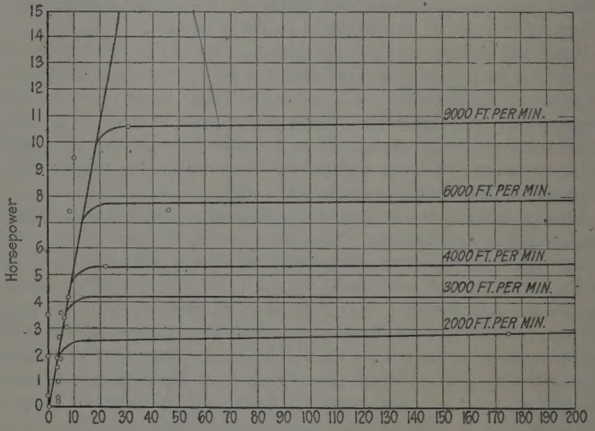

FIG. 4 CURVES SHOWING RELATION BETWEEN VELOCITY OF SLIP AND HORSEPOWER FOR T_1 = 100 LB.

Since the quantity $T_1 - T_2$ is more valuable for use in connection with this work than the quantity T_1, it was found desirable to provide some means of showing the relation of $T_1 - T_2$ to the other variables.

To do this the values of $T_1 - T_2$ were computed for various points on the diagram, and after marking the values in their proper places contours were run so as to show the lines of constant $T_1 - T_2$. The intersections of constant-hp. lines and constant-speed lines were used for this purpose and the corresponding values of $T_1 - T_2$ were computed from the following relation:

$$T_1 - T_2 = \frac{33{,}000 \times \text{Hp.}}{V_d}$$

This diagram may be used in connection with the design of a steel belt within the range of the values used, and of course applies only to steel belting of the same size as used in the test and run over cork-faced pulleys.

For any belt speed the maximum horsepower which can be transmitted with a given tension and the corresponding velocity of slip and $T_1 - T_2$ can be determined. For instance, if we wish to transmit 10 hp. we have a large range of values of both T_1 and belt speeds from which to make a choice, but when either of these values is fixed, the other assumes a definite value.

It must be remembered in using this diagram that owing to the method of its construction some of the quantities represent not the absolute values, but the limiting values corresponding to the others which have been fixed. Thus if we assume a belt speed of 6000 ft. per min. with the original assumption of 10 hp. transmitted, it will be seen that T_1 will have a value of about 135 lb. This means that with the conditions which were assumed (10 hp. and 6000 ft. per min.) any value of T_1 less than 135 lb. would be below the limiting value and that excess slip would be expected. It would be advisable, however, to use a somewhat higher tension, since in this way the velocity of slip would be materially decreased.

On the other hand, if we wished to find what speed would be necessary if we assumed T_1 to be, say, 200 lb., from the diagram it appears that a speed of about 3600 ft. per min. would be the least speed at which 10 hp. could be transmitted without excess slippage, and at this condition the slip would be about 12½ ft. per min. Here again it would be advisable to either increase the speed or the tension, in order to work safely below the critical point, because the relations on the diagram represent conditions which correspond to the points on the straight lines of the V_s and hp. curves at which the holding power of the belt on the pulley breaks down and a very great increase in slippage begins.

By extending this diagram to cover a large range of hp., belt velocity and tension, and applying certain coefficients to compensate for changes of belt size and other variables which may occur, a complete working diagram for steel-belt design would be obtained.

The next relation which was wanted was that of the coefficient of friction to the velocity of slip. The method used in calculating these values has been previously explained, the values of V_s used being the corrected values obtained by the method before described.

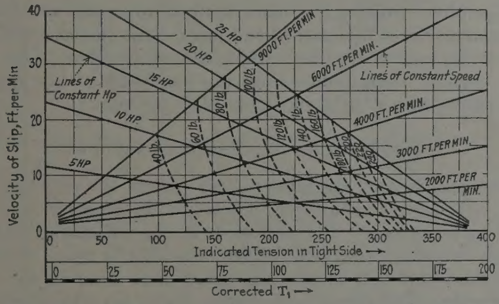

FIG. 5 CHARACTERISTIC DIAGRAM FOR STEEL BELTING

This diagram was constructed from the data and computed values obtained from the tests. It shows the relations which exist between the several variables involved, particularly as these relations are controlled by the points which determine the limiting conditions; that is, the point where excess slippage begins. The dotted lines represent lines of constant $T_1 - T_2$.

Fig. 6 shows the curves obtained, and it was found that not only does the coefficient of friction vary with the velocity of slip but also with the belt speed, increasing with increased velocity of slip and with a decrease of speed.

A rather interesting feature was discovered in connection with the computation of the values of the frictional coefficient. In using the quantity

$$\log \frac{t_1 - t_c}{t_2 - t_c}$$

it was found that for some readings the values of $t_2 - t_c$ became negative, and hence the expression

$$\frac{t_1 - t_c}{t_2 - t_c}$$

also became negative.

Investigation of the curves showed that such values appeared to develop at or near the points where the hp. and V_s curves broke away from their common characteristic line.

Very little can be determined for these values from the experimental data taken, and it is evident that such points are outside of the practical range for the use of steel belting. The phenomenon can, however, be explained as follows:

Whenever the value of t_c became greater than the existing value of t_2, which is the condition under which $t_2 - t_c$ is negative, it is evident that there was no force acting to keep the belt in contact with the pulley on the loose side. Accordingly, the arc of contact was diminished and conditions brought about which gave rise to the unstable and uncertain conditions which showed up in the experimental work.

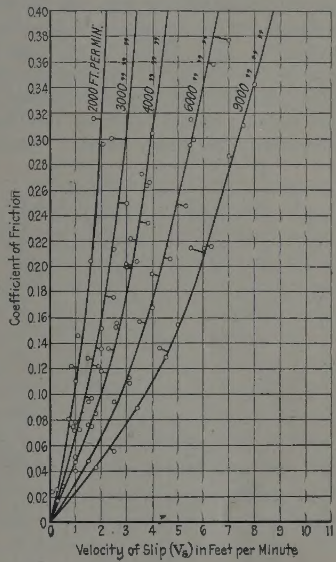

FIG. 6 CURVE SHOWING RELATION BETWEEN VELOCITY OF SLIP AND COEFFICIENT OF FRICTION

In obtaining the values of the coefficient of friction an attempt was made to compute them from the relation:

$$\text{Ft-lb. lost due to friction} = u\,p\,r\,\theta\,V_s$$

where u = coefficient of friction
p = pressure per unit length of belt on pulley face
r = radius of pulley
θ = angle of contact in radians
V_s = velocity of slip.

Assuming that the total power loss due to friction is also equal to the product of the velocity of slip by the difference in tension,

$$(T_1 - T_2)\,V_s = u\,p\,r\,\theta\,V_s$$

and since

$$p = \frac{T_1 + T_2}{2r\theta}$$

$$V_s(T_1 - T_2) = u\frac{T_1 + T_2}{2r\theta}r\theta V_s$$

or

$$u = \frac{2(T_1 - T_2)}{(T_1 + T_2)}$$

Fig. 7 shows the curves plotted from this relation, but on account of their being independent of V_s, values of u were obtained in another manner.

DISCUSSION OF BELT JOINTS

One of the serious difficulties which had to be contended with was the development of some method of joining the ends of the belt in such a way as to develop a fair proportion of the tensile strength of the steel belt and at the same time not to interfere with the smooth operation of the belt and to be of such a nature that the joint will be sufficiently durable.

The following requirements are those which determined the most desirable joint to use:

a In order that there shall be the least possible amount of concentrated strain it is necessary either to have the joint extend along the belt as small an amount as possible, or to have it so constructed that its flexibility is approximately equal to that of the original belt. If the joint is of such construction that there is a distinct change in the flexibility in adjacent sections, the stresses would be so concentrated at the junction point that destructive stresses would cause an early failure of the material.

b On account of the design of the testing machine it was necessary that the joint would be capable of withstanding reversed stresses and that nothing should interfere with using both sides of the belt in contact with the pulley wheels. This condition, while being essential for the test, is not necessarily applicable to all installations, because for ordinary straight drives only one side of the belt is run in contact with the pulleys.

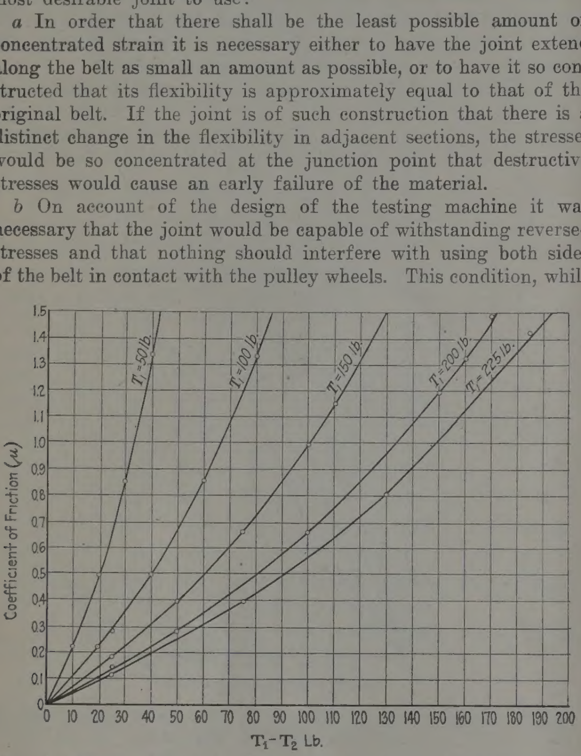

FIG. 7 CURVES SHOWING RELATION BETWEEN COEFFICIENT OF FRICTION AND DIFFERENCE OF TENSION

c The material of the belt is a very high-carbon steel carefully tempered and any joint which depends upon the use of solder must be made in such a way that the original temper is either not drawn or that it is drawn to only such a degree that the material is not damaged.

It can be readily seen that a joint could not be retempered without tempering the entire belt, because there would be a section each side of the heated part which would have received enough heat to draw its temper and still would not be hot enough to harden.

Efforts were made to develop a joint which satisfied the foregoing requirements, and after much experimentation it was found that the most successful manner of joining the belt ends, so far as the test was concerned, was to make a butted joint with the edges beveled about 60 deg. and then secured by means of silver solder. Care was taken to confine the annealing effect of the soldering flame to as small a length along the belt as possible and only enough solder was used to make the joint complete. With the $\frac{3}{4}$-in. belt it was possible to confine the annealing effect to a very small length (as little as $\frac{1}{2}$ in.), and to so distribute the solder that it was not necessary to do any filing in order to make the joint ready for service.

Joints of this kind were used throughout the test with apparently no signs of weakening or failure and showing no undesirable effects on the running stability of the belt.

An attempt was made to weld the belting by means of an oxy-acetylene torch, but on account of the extreme thinness of the material and the high temperature required it was unsuccessful.

In an attempt to make a joint which would develop a large percentage of the original strength of the material, one of the ends to be joined was cut to a sharp V and the edges serrated, and the other end so cut as to interlock with it. It was expected that when this joint was silver-soldered the strain would be taken up by the material instead of by the solder as it would be with the simple butt-soldered joint. This method was not a success, because when heated to a sufficiently high temperature to flow the solder it buckled and twisted and could not be made flat.

Riveted joints were also tried and proved fairly satisfactory. The joints were made in the V-shape in order to distribute the rivets and both ends were cut out so that the tendency to stiffen the joint would be reduced to a minimum. They were made by the use of a punching die into which one end of the belt was clamped and 15 No. 50 holes were punched. The other end was punched in the same die, being put through from the opposite end so that the holes in the two pieces exactly matched. The rivets used were No. 51 punchings from phosphor bronze about 0.03 in. thick. These were placed in the holes and headed down lightly on both sides, care being taken not to stretch the material by upsetting them too much. A joint of this type was run for a considerable length of time and then a very small crack was discovered in the edge. It is the opinion of the authors that with sufficient care and experimentation a very satisfactory riveted joint could be developed.

PART II INVESTIGATION OF SLIP

IN carrying out the work described in Part I both Hampton and Leh realized that certain relationships existed between the horsepower transmitted by the belt, velocity of slip of the belt on the pulleys, and the coefficient of friction, but owing to the very large error in their observed data on velocity of slip, they were unable to find such expressions as have been developed below.

The difference of r.p.m. of the driver and driven pulleys as observed by the above authors was subject to a large error in that the revolution counters used did not read less than unity. One revolution would correspond to a slip of 8.625 ft. per min. were the observation period one minute long, as the circumference of both pulleys was 8.625 ft.

Hampton, realizing that more accurate apparatus was necessary to measure the slip, designed and partly constructed a differential revolution counter that was completed by the author. This revolution counter would indicate one one-hundredth of one revolution difference, with a probable error of 5 per cent.

THE DIFFERENTIAL REVOLUTION COUNTER

The positions of the idler pulleys reverse the direction of the belt, and hence the direction of rotation of the driver and driven pulleys is opposite. The mechanism of the differential, as is commonly known, is such that the two wheel shafts rotate in opposite directions and with equal r.p.m. when there is no rotation of the ring gear. The driver and driven shafts are connected 1 to 1 to the wheel shafts by light chains and sprockets. Hence, if the driver and driven pulleys are rotating with the same speed, the ring gear is stationary. The pulleys having equal circumferences, no slip would be in evidence when this were the case. However, as soon as the belt began to slip, the ring gear would rotate in proportion to the difference of peripheral velocity of the two pulleys.

The ratio of the ring gear to the pinion is 1 to 20, and that of the differential gears is 1 to 1, making the ratio of the wheel shaft to the ring pinion 1 to 10. A disengaging coupling is connected to the ring pinion, by means of 1-to-1 sprockets and light chain, and is operated by the solenoid which in turn is controlled by the knife switch. This coupling has twelve teeth on one side and a knife edge on the other, making the probable error 1/24 or 4.16 per cent. In order that the chain be kept tight, a friction brake was put in between the sprocket mounted on this coupling shaft, and its supporting standard.

The revolution counter used was one specially constructed for this particular use. The unit wheel being divided into tenths gave a ratio of 1 to 100 from the wheel shaft to the counter. Hence the difference of r.p.m. of the driver and driven shafts was determined quite accurately, that is, to one one-hundredth of a revolution, which in terms of the pulley circumference is 0.0863 ft.

It was found after running some time that the vibration of the chains connecting the pulley shafts to the revolution counter caused them to become stretched in places, effecting a slight rotation of the ring gear first in one direction and then in the opposite. This appeared to vary with the speed, but, as nearly as could be determined, a probable error of from 1 to 2 per cent might be introduced.

Through all tests this machine served its purpose very accurately and was a great help in adjusting the load on the Sprague dynamometer, for the point at which the belt began to slip excessively could be observed at a glance. Without this machine the data on the slippage of the belt would be so inaccurate that the results of the tests would have been useless.

Belt Material and Joints

The material used for belting in this test was clock-spring steel ¾ in. by 0.01 in. It is manufactured in this country from Swedish high-carbon charcoal steel, drawn, rolled, ground to size and tempered to a dark blue. It can be obtained in widths of from ½ in. to 3 in. and 0.01 in. thick and costs from 6 to 18 cents per ft.

Tests of this material show the ultimate strength to be over 300,000 lb. per sq. in. and the elastic limit slightly less. The belt used in this test had no permanent set when bent around a radius of ¾ in. but it was found it would rupture when bent around a radius of $\frac{1}{16}$ in.

When the belt bends around a pulley, as much work is put into bending it as appears when the belt straightens out on leaving the pulley. This is not true of any other kind of belt, as power is required to bend it and again to straighten it out.

The joint used on the belt tested was a silver-soldered lap joint. It proved very satisfactory throughout all tests and showed no signs of necking-in where the temper had been drawn. These joints when tested have an efficiency of about 60 to 65 per cent in pure tension, the rupture taking place on either side of the lap where the metal has been softened.

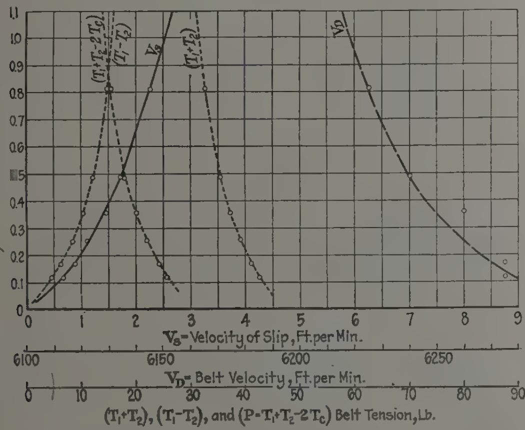

Fig. 8 Characteristics of a 0.75-in. by 0.01-in. Steel Belt

Owing to the low efficiency of the silver-soldered and brazed joints, a dozen or more riveted joints were constructed. Phosphor-bronze rivets were used and one triple-riveted lap joint by test had an efficiency of 84 per cent, rupture occurring by shearing all the rivets. This joint could not be used on pulleys smaller than 30 in. in diameter.

Other similar lap joints averaged 76 per cent by test when cold-drawn iron wire was used for rivet material.

Owing to the idler pulleys reversing the motion, one side of the belt runs on the driven pulley and the other side on the driver pulley, consequently it was necessary to have both sides of the belt joint as smooth as possible.

The type of joint used in an installation of steel belting in one of the shops was of the bent cover-plate type and would have been quite successful had the pulley on the motor been of larger diameter. This cover plate was bent to conform with the curvature of the smaller pulley, and the ends were bent up on a radius of ¾ in. It appeared that the tangential acceleration of the joint as it came on to the motor pulley kept the joint from following the pulley curvature. This induced flexure in the belt, just ahead of the first row of rivets, and the combined stress of the tension and flexure being in the neighborhood of the elastic limit caused rupture after 15 to 20 hr. operation.

It is the opinion of the author that this type of cover-plate joint would be quite satisfactory for use on pulleys of not smaller radius than 15 in.

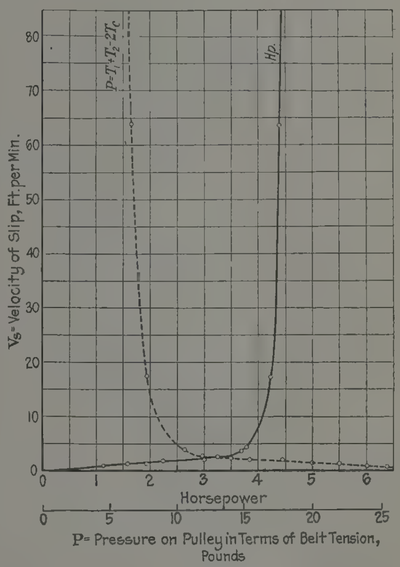

Fig. 9 Characteristics of a 0.75-in. by 0.01-in. Steel Belt

Description of Tests

The calibration of the weights and spring balance was made just after the differential revolution counter was completed. The work checked quite well with the calibration made by Hampton and Leh.

Several preliminary runs were then made to determine the capacity of the motor and the variations of speed with load. A preliminary curve run was then made. A tension of 23.6 lb. in the tight side of the belt was selected in order that the tension in the loose side could be made practically zero, allowing an excessive slip. The speed selected would also bring in the characteristics of the motor and allow a certain change in the centrifugal tension of the belt. The curves resulting from this set of values and shown in Figs. 8 and 9 will be discussed below.

The four speeds of the motor with the arrangement of pulleys then on the machine would give belt speeds of about 3150, 4770, 6250 and 9450 ft. per min. In order that a wider range of belt speeds could be obtained, a large pulley and a small pulley could be placed on the driver-pulley shaft, and with these pulleys belt speeds of 2080 and 14,500 ft. per min. could be obtained.

Seven runs were made with each velocity for various tensions in the tight side of the belt. The smallest is 23.6 lb. and corresponds to 50 lb. on the weight pan, while the largest is 111.6 lb.

and corresponds to 225 lb. on the weight pan. The interpolated results for $T_1 = 99.0$ are given in Table 2.

The run was always begun at the highest horsepower possible, and from five to six observations made as the hp. varied to zero. The load could be held quite constant throughout each run when the Sprague dynamometer was separately excited, but near the end of the test period, when the generator was self-excited, some difficulty was experienced in making all the observations. Before a run was begun, the surfaces of the cork pulleys were always cleaned in order that the conditions of the test might be the same.

The following values were observed and will be discussed below:

$(T)_1$ = tension in lb. on the idler over which the tight side of the belt passes; observed by the weights on the weight pan

T_1 = corrected tension in the belt in lb. as taken from the calibration curves

$(T)_2$ = tension in lb. on the idler over which the loose side of the belt passes; observed by the reading of the spring balance

T_2 = corrected tension in the belt in lb. as taken from the calibration curves

N = r.p.m. of the driver pulley; observed from the reading of the electrically operated Veeder revolution counter

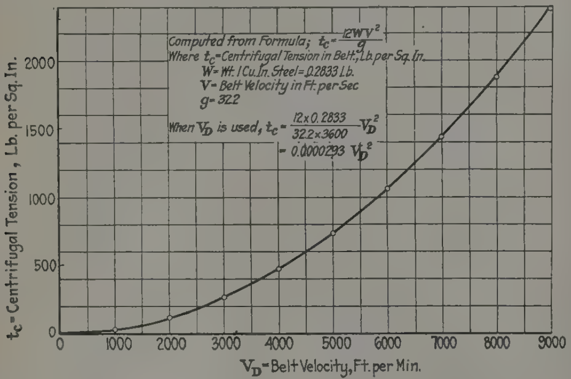

FIG. 10 CURVE OF CENTRIFUGAL TENSION FOR BELT SPEEDS UP TO 9000 FT. PER MIN.

n = difference of r.p.m. of the driver and driven pulleys as observed from the differential revolution counter.

A reading of the brake arm on the Sprague dynamometer was also taken and used as a check on the power transmitted.

NOTATION

T_1 = actual tension in the tight side of the belt in lb.

t_1 = actual unit tension in the tight side of the belt in lb. per sq. in.

T_2 = actual tension in the loose side of the belt in lb.

t_2 = actual unit tension in the loose side of the belt in lb. per sq. in.

T_c = centrifugal tension corresponding to the velocity at which the belt is passing around the pulleys in lb.

t_c = actual unit centrifugal tension in lb. per sq. in.

$T_1 - T_2$ = difference in belt tensions in lb. or the useful force in the transmission of power.

V_d = belt velocity in ft. per min.

V_s = computed velocity of slip of the belt relative to the pulley in ft. per min.

V_{sc} = velocity of slip of the belt in ft. per min. corrected from the curves where Hp. $= 0.17 T_1^{0.55} \times V_s$

P = actual tension in belt producing pressure on pulley, lb.

p = pressure in lb. per sq. in. per unit length of belt on the pulley face

W = weight of 1 cu. in. of steel in lb.

g = gravitational force

r = radius of driver and driven pulleys in ft.

u = coefficient of friction

θ = angle of contact in radians the belt makes on the pulley face.

TABLE 2 DATA AND RESULTS OF TEST ON 0.75 x 0.01-IN. STEEL BELT

Run No.	T_1	T_2*	P	V_d*	Hp.	u	V_{sc}
R-4	99.0	22.6	120	2018	4.67	0.482	1.37
	....	23.4	...	3000	6.98	0.481	2.05
	....	29.0	...	4600	9.76	0.440	2.88
	....	35.6	...	5750	11.03	0.376	3.24
	....	56.4	...	8920	12.76	0.236	3.76
	99.0	43.0	140	2033	3.45	0.269	1.01
	....	45.0	...	3070	5.25	0.260	1.48
	....	50.0	...	4610	6.84	0.234	2.00
	....	57.0	...	6040	7.69	0.162	2.26
	....	79.0	...	9300	5.64	0.092	1.66
	99.0	63.0	160	2068	2.255	0.145	0.66
	....	65.0	...	3100	3.195	0.137	0.93
	....	70.0	...	4680	2.980	0.117	0.87
	....	78.0	...	6200	3.950	0.084	1.16
	99.0	83.0	180	2075	1.005	0.057	0.30
	....	85.6	...	3163	1.286	0.046	0.84
	....	90.8	...	4740	1.178	0.029	0.35
	....	98.0	...	6250	0.189	0.004	0.05

* Interpolated values.

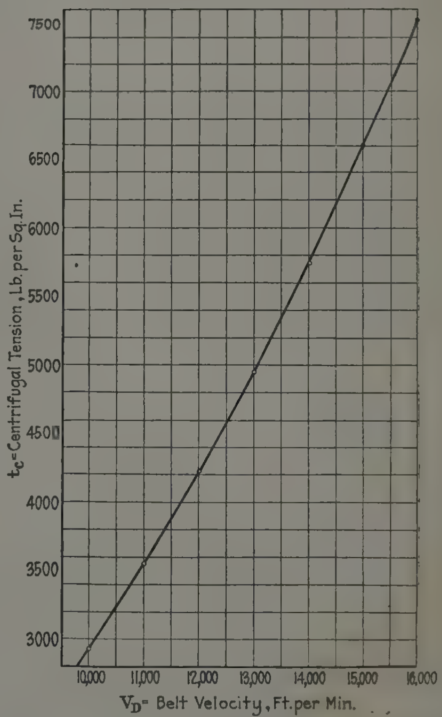

FIG. 11 CURVE OF CENTRIFUGAL TENSION FOR BELT SPEEDS UP TO 16,000 FT. PER MIN.

DISCUSSION OF CURVES

The computations necessary in working out a set of values involved a great number of operations. An attempt was made to plot curves of various functions that would constantly enter into certain equations.

The values of t_c and T_c were first computed and plotted as shown in Figs. 10, 11, and 12. The equation for unit centrifugal tension is

$$t_c = \frac{12WV_d^2}{g}$$

where $W = 0.2833$ lb.
$g = 32.2$

and in this equation V_d is in ft. per sec. If V_d is to be used in ft. per min., the equation becomes

$$t_c = \frac{12 \times 0.2833 \times V^2_d}{32.2 \times 3600}$$
$$= 0.0000293\, V^2_d \text{ lb. per sq. in.}$$

As $T_c = t_c \times A$, the multiplying factor then becomes

$$T_c = 0.0000293 \times 0.01 \times 0.75 \times V^2_d$$
$$= 0.00000022 V^2_d$$

Computations of all observed data were then made and the results tabulated, the equations employed being given below.

Circumference of driver and driven pulleys = 8.625 ft.

$$V_d = \left(N - \frac{n}{2}\right) \times 8.625 \text{ ft. per min.}$$

$$t_1 = \frac{T_1}{0.0075} \text{lb. per sq. in.}$$

$$\text{Hp.} = \frac{(T_1 - T_2)V_d}{33{,}000}$$

where $T_1 - T_2$ = force in lb.
V_d = distance

$$\text{Efficiency} = \frac{\text{Hp.} - (T_1 - T_2)V_{sc}}{\text{Hp.}} \times 100 \text{ per cent}$$

$$u = \frac{\log_{10}\dfrac{t_1 - t_c}{t_2 - t_c}}{0.43430}$$

$$V_s = \frac{n}{2} \times 8.625 \text{ ft. per min.}$$

The above equation for u is derived in Smith and Marx' Machine Design.

Curves of all relations that might possibly exist were then plotted as are shown in Figs. 8 and 9.

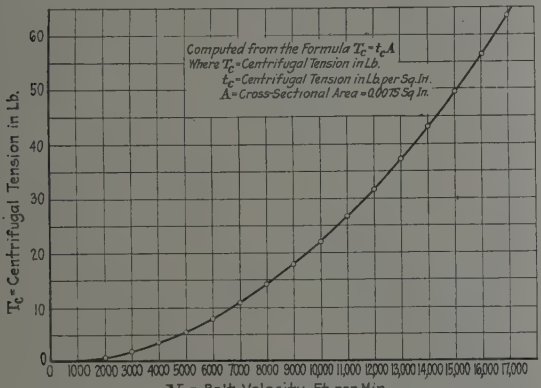

FIG. 12 CURVE OF CENTRIFUGAL TENSION FOR BELT SPEEDS UP TO 17,000 FT. PER MIN.

The most noticeable relation is that of velocity of slip and horsepower. This curve shows practically straight-line variation up to a certain point where the velocity of slip increases very suddenly. Inspection of the data shows that at this point $t_2 = t_c$ and hence there is no pressure on the pulley where the belt leaves the driven pulley. As this is the case, it would be expected that the velocity of slip would become excessive.

The curve of P as a function of slip shows that the pressure decreases with an increase of slip up to a point where the pressure decreases but slightly with a large increase of slip. As can be seen from these two curves, the pressure on the pulley and the horsepower are related, but for the present the most striking relation appears to be in the curve of horsepower and slip.

The relation between the coefficient of friction and velocity of slip apparently exists in Fig. 8. This is a misconception, for the curve should not pass through zero, since the coefficient of friction of rest between cork and steel is not zero. All that this curve indicates is that the coefficient of friction at zero velocity and zero slip is indeterminable, due to other variables. It may also be noted that the belt velocity is not constant and that the pressure varies.

A relation between u and $T_1 + T_2$ was suspected, but after some investigation it appeared that T_c entered into this factor. It was then that the pressure curve was plotted, and although it has no significance as it appears here, it was necessary in the work that was to follow.

METHOD OF OBTAINING RESULTS

The first relation that was attempted was that between hp. and V_s. It was noticed that for a constant value of T_1 all the points up to certain limits would fall on a straight line. These curves were plotted, the curve for T_1 = 99 lb. being shown in Fig. 13. A dashed line was then drawn such that the estimated slope would as nearly as possible coincide with the mean average of the points. In these curves this line is a light dashed one and noted by the word "Estimated." It must be remembered that in these curves all points in the vicinity or above that where $t_2 = t_c$ are not plotted. The figures on the right show the belt velocity and hp. at which $t_2 = t_c$.

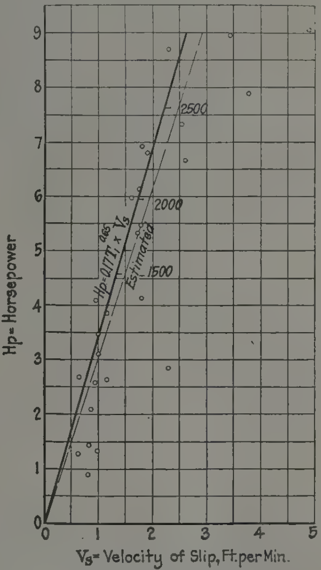

FIG. 13 CURVES SHOWING RELATION BETWEEN VELOCITY OF SLIP AND HORSEPOWER

When this was done for all values of T_1, the slope was found and tabulated with the corresponding value of T_1. The equation of a straight line passing through zero is $Y = mX$, where m = slope. With this in mind the slope m was plotted as a function of T_1, and resulted in a parabolic curve. To determine the equation of this new curve the data were plotted on logarithmic cross-section paper. The result was a straight line which had 0.17 for its intercept and a slope of 0.65, indicating that the slope m was equal to 0.17 $T_1^{0.65}$.

From this it was a simple matter to deduce the equation—

$$\text{Hp.} = 0.17\ T_1^{0.65} V_s$$

As all of the points of the estimated slope m did not fall on the logarithmic curve, another line, the slope of which was computed from the above equation, was drawn on the curves and noted by the equation.

The values of the velocity of slip were then corrected by the use of these curves and the corrected value was tabulated as V_{sc}.

Fig. 13 was then plotted to give an idea of the relation of hp. to V_{sc} at various values of T_1. The lines of constant T_1 are shown as solid straight lines. The light dashed lines are lines of constant

V_d and the points of intersection with the lines of constant V_d were computed from the equations—

$$\text{Hp.} = (T_1 - T_2) \times V_d$$
$$T_2 = T_c = 0.00000022\, V^2_d$$

The relation of u to V_{sc}, V_d and P was more difficult to determine owing to the large number of variables. An attempt was made to select groups of values from the observed data where two of the values remained constant. This could not be done for enough values to find a relationship between the other two variables, and for a time the solution looked much more difficult. It seemed that new data must be taken or that interpolations must be made from the data already at hand. As the taking of new data, such that two of the variables remain constant, was impractical for but one observer, interpolated data had to be computed. The values of T_2 and V_d were interpolated from curves and the observed data.

A large number of groups were selected, and in each group two and sometimes three sets of values of the two variables could be obtained when the other two remained constant. These values were plotted on logarithmic cross-section paper and were found to be straight lines having approximately the same slope. For example, the relationship between u and V_{sc} is shown in Table 3 for one value of P throughout the set of groups.

TABLE 3 RELATIONSHIP BETWEEN u AND V_{sc}

Run No.	Constants		Variables		Relation
	P	V_d	u	V_{sc}	
R-1	70	5000	0.143	1.20	
R-2	..	....	0.360	2.75	$u = 0.1\, V_{sc}^{1.375}$
R-1	..	4000	0.190	1.15	
R-2	..	....	0.465	2.25	$u = 0.155\, V_{sc}^{1.375}$
R-1	..	3000	0.271	1.00	
R-2	..	....	0.515	1.80	$u = 0.223\, V_{sc}^{1.375}$
R-1	..	2000	0.240	0.75	
R-2	..	....	0.550	1.25	$u = 0.386\, V_{sc}^{1.375}$

Data similar to those in Table 3 were obtained for pressures of other values and the relation found. The exponents in each were averaged and found to be 1.37, it then being evident that

$$u = V_{sc}^{1.37} \times f(P) \times K \times f(V_d)$$

where K is some constant.

The characteristics of the curves plotted of u as a function of V_d and P when V_{sc} was constant, showed that V_d and P varied inversely according to some power. Interpolations and computations similar to the above were made, and it was found that u varied inversely as some constant multiplied by the square root of P. Again the same methods were followed, and it was found that u varied inversely as some constant multiplied by $V_d^{1.5}$.

This gave the equation

$$u = \frac{V_{sc}^{1.37} \times K}{p^{0.5} \times V_d^{1.5}}$$

and 75 values of K were solved from the equation

$$K = \frac{u \times p^{0.5} \times V_d^{1.5}}{V_{sc}^{1.37}}$$

The values varied from 2.71×10^6 as a minimum to 4.04×10^6 as a maximum. The majority, however, were in the neighborhood of the average, which was 3.1992×10^6.

The final deduction of the relation of u to the other variables is given by the equation

$$u = \frac{V_{sc}^{1.37} \times 3.2 \times 10^6}{p^{0.5} \times V_d^{1.5}}$$

CONCLUSIONS

The first equation found in this investigation is useful in determining the tension in the tight side of the belt, when a given amount of power is to be transmitted and a reasonable velocity of slip (not greater than 3 ft. per min.) is assumed. The wear on the pulley facings is in proportion to the velocity of slip, and hence it is advisable to keep this value as low as possible to prevent wear. Knowing this tension, the belt may be cut to length by computing the total elongation due to the tension, and the distance that the cork will be depressed due to this tension. The belt may then be joined and placed on the pulleys.

The second equation, while not as practical as the first, is interesting from the technical nature with which the different factors vary the value of the coefficient of friction as the range of power transmission is passed over. The coefficient of friction of rest between cork and steel at a given pressure would not appear to be zero as this equation would indicate were the velocity of slip zero.

The efficiency of transmission was always so near 100 per cent that it was not tabulated in the data. Only in extreme cases did it fall below 98 per cent, and the author spent but little time on this computation.

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A paper on Recent Advances in Utilization of Water Power, by Eric M. Bergstrom, of London, read before the Institution of Mechanical Engineers, January 23, 1920, directs attention to the main lines along which the development of this highly-specialized branch of engineering has taken place, and indicates briefly its general effect on the utilization of water power. In considering these developments as described in the paper, Mr. Bergstrom summarizes the outstanding features as follows:

a The exclusive use of two types of turbines only, namely, Francis reaction turbines for low and medium heads and Pelton impulse wheels for high heads

b The extension of the use of Francis turbines under heads approaching 800 ft. and Pelton wheels in single stage up to 5500 ft.

c The exclusive adoption of balanced wicket gates for the regulation of Francis turbines and the circular nozzle with combined deflector and needle regulation for Pelton wheels

d The standardization of turbine runners and increased specific speed permitting the use of single vertical units of large output under low heads

e The general increase of output per unit, the maximum output at present being 31,200 hp.

f The general increase of the overall efficiency of about 6 per cent to 10 per cent

g The exclusive use of oil-pressure governors

h The efficient regulation (by means of differential surge tanks) of turbines using long pipe lines

i The employment of large-diameter pipe lines under high heads, resulting in an appreciable reduction of the initial cost of development.

These developments, coupled with the improved construction of impounding dams in addition to multifarious improvements in details to insure effective safeguards and reliability in operation, constitute as such an enormous advance from a purely technical point of view, but of even greater significance has been the unlimited field thereby opened up for the application of electricity and the extended scope given to the utilization of water power in the service of civilization; issues of the greatest magnitude have been raised affecting the economic life and future prosperity of nations, and from being a question to be left solely to private enterprise, the control and development of water power now rank among the vital problems of national interest.

Design of Ore Fleet for Upper Mississippi

Economy of River Transportation of Ore as Shown by Experimental Trips on Upper Mississippi River—Particulars Regarding Design and Construction of Barges and Towboats—Terminal Facilities Projected, etc.

By WILLIAM S. MITCHELL,[1] ST. LOUIS, MO.

This paper deals principally with the design of an ore fleet for the upper Mississippi River. The author describes two experimental trips which were conducted during the war to try out the possibilities of such transportation on the Mississippi. The results of these experimental trips warranted the construction of a fleet of 24 barges and 4 towboats for traffic of ore and fuel on the upper Mississippi River. The writer, as engineer of the U. S. Engineer Office at St. Louis, was in charge of the design of these vessels and describes the difficulties encountered and the manner in which they were handled. He also gives information concerning the fleets for the lower Mississippi River and the Warrior River, and the terminal facilities being developed in cities and towns along these rivers.

In the Spring of 1917, after this country had entered into the world war, it was quickly realized that the transportation of materials for the manufacture of munitions and equipment presented one of the most important problems to be solved, especially as the movement of large bodies of troops and their impedimenta soon began to crowd and embarrass the railroads to the point of breakdown. For relief, in part, the use of the waterways was early suggested, and in May of that year a decision was reached by the War Department, with this idea in view, to aid in transportation on the Upper Mississippi River of iron ore from Minnesota ore fields to the coal fields of the Middle West, to increase, in blast furnaces there, the production of pig iron for the manufacture of steel near St. Louis. This effort started with a small improvised fleet composed of six steel barges of the U. S. Engineer District at St. Louis, each of 600 tons capacity, and a steel-hull stern-paddle-wheel towboat of ordinary western river type, from the Mississippi River Commission. This fleet was assigned to a lessee to try out the possibilities of the upper river for such traffic, and, loaded with about 3000 tons of Illinois coal to be sold at St. Paul to meet in part the expense of the undertaking, left St. Louis July 31, at the beginning of the annual low-water season, and proceeded without incident upstream, arriving at destination in the middle of August.

At St. Paul considerable delay ensued in unloading at the water front the unusual quantity of coal, and in obtaining and loading ore for the return trip. An extra quantity of ore having been delivered by error of the railroad and ore companies, four more small wooden barges were borrowed at St. Paul from the Engineer Department, for its transport, and were added for the downstream trip to the tow, already rather too large and heavily laden for the prevailing river stage, which had been falling steadily until the conditions almost reached the recorded low limits for a navigable season.

The whole fleet, with about 3400 tons of ore, left St. Paul August 28, and although the draft of the barges was at the extreme limit permitted by the channel depths, they were floated over the shoals and bars with fair success; but the towboat, built for the deeper water of the lower river, was of slightly greater draft, passing that limit, and grounded at nearly every river bar encountered. Then, too, as the boat was nearly touching bottom at many other places, it lost control of the tow, and the barges also were frequently grounded in the soft river sand. Other smaller and lighter-draft boats were brought to the assistance of the struggling fleet, and after two months of incessant effort the vessels arrived at St. Louis.

Meanwhile a similar second fleet had been collected at St. Louis and, loaded somewhat more lightly with coal, had started north, but because of the fallen river it was unable to proceed much beyond the mouth of the Illinois River, to which stream it was diverted, and after discharging cargo at Hennepin it returned to St. Louis.

The seemingly disastrous southbound trip from St. Paul unfortunately created a strong impression of unsuitability of river transportation to modern needs; but as a matter of fact, that trip, made at such an extraordinarily low stage, developed practically and commercially the fact of an excellent, well-improved river channel for nearly 700 miles between the cities named, available to at least 4 ft. depth for wide tows of barges during the low-water season, increasing at high stages to 8 and 9 ft., which guarantees to vessels built specially for such shoal depths a capacity for transportation far beyond that of any railroad. As the route by rail from the Minnesota ore fields to St. Paul and thence by river 675 miles to St. Louis is about 200 miles shorter than the prevailing route by rail to the lakes and thence by water to southern lake ports and again by rail to St. Louis; and as the ore is always at hand in full-capacity quantities for the down trip, and the coal, eagerly sought in the north, is equally plentiful for the upstream haul, there is offered an ideally balanced through traffic, commercially profitable even with these low-grade (tariff) commodities, which, if continually carried in large quantities, cannot fail to effect great economy in the transportation costs of both.

Upper Mississippi Fleet

As a war measure, to increase the production of pig metal and in contribution to the relief of the acutely felt shortage in ore and coal cars, the United States Shipping Board, Emergency Fleet Corporation, made an allotment of $3,360,000 for the construction of 24 barges and 4 towboats, to be entirely of steel, and specially designed for this through traffic of ore and fuel on the shallow Upper Mississippi River. The number of barges was afterward reduced to 19 and the funds increased to $3,860,000 to aid in the construction of terminal loading and unloading apparatus.

Design and Construction of Barges

The design of the vessels fell to the writer's charge under the U. S. Engineer Office at St. Louis, under the War Department, and in this work most valuable counsel and assistance was freely given by Mr. M. H. Von Pagenhardt, Naval Architect, formerly with the Kansas City-Missouri River Navigation Co., and by Mr. J. W. Gerell, Naval Architect, Mississippi River Commission, both at St. Louis.

As is well known, large barges offer (*a*) greater carrying capacity per unit of fleet area and draft, (*b*) lower cost for construction and upkeep, and (*c*) less resistance in propulsion with consequent reduction in transportation cost per unit of capacity than a fleet of smaller vessels aggregating the same capacity. With these considerations in view, the dimensions of the barges were fixed just within the physical limits set by bridges and locks in the river reach to be navigated.

The dimensions chosen for the barges were 300 ft. length, 48 ft. width or beam, and 10 ft. depth. The length, 300 ft., of the locks on the rapids at Moline and Le Claire fixed the length of the component barges. The minimum channel clearance for the bridges, with one exception, is about 150 ft., thus the width of a unit fleet or tow was limited to about 144 ft. A width of 48 ft. allowed three barges to be grouped about each towboat, the most advantageous arrangement in towing, without necessity of breaking tow when running through the many bridges. The depth provided the necessary longitudinal strength and stiffness of hull.

With these dimensions it was found that such a barge would

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Abstract of a paper presented at the Spring Meeting, St. Louis, Mo., May 24 to 27, 1920, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK. All papers are subject to revision.

carry about 850 tons of cargo on a draft of 4 ft. during low water, increasing at high stages to 2500 tons on 8-ft. draft when going upstream, and to 3000 tons on 9-ft. draft when floating over the bars coming downstream. It was estimated that the annual average load would be 1500 tons per barge, making 4500 tons per tow each way, and also, that about 16 round trips for each boat could be made during the boating season of 7 to 8 months, giving a unit annual capacity to each towboat of 144,000 tons, or, 576,000 tons to be moved by the fleet annually between the cities. The barges, therefore, were laid down on this basis.

It was found that Minnesota ore at about 115 lb. per cu. ft. could be readily carried as a deck load to the capacity limits assigned by the construction of necessary bulwarks 5 ft. high entirely around the barge. Also this would permit the use of the full unbroken deck as an upper chord to the barge considered as a girder, giving the desired longitudinal strength of structure with minimum weight of metal. But the full deck had to be abandoned as the upstream capacity cargo of coal could not be adjusted to these conditions, because the much greater bulk of coal per ton (about 55 lb. per cu. ft.) would require piling so high above deck as to be dangerous, and this compelled sinking the latter in the form of a great hopper, or open hold, 5 ft. deep, the barge thus losing longitudinally the strength of the sunken part of the deck which becomes the hopper bottom near the neutral axis of the vessel.

Longitudinal strength of structure was therefore given by wide (6 ft.) deck stringers on each side of the hopper, increased by a steel combing 1 ft. high above deck, running entirely around the hopper and adding to the depth of the latter.

The final dimensions of the cargo hopper are: an unbroken length of 256 ft., 36 ft. width, and 6 ft. depth. The hopper is drained at the corners and middle of each side by 4-in. drain pipes passing through the barge at about the 4-ft. draft line, and controlled from the main deck by proper valves. The hopper bottom is of ¼-in. plate, supported on longitudinal 6-in. channels spaced 12-in. centers as deck reinforces, to withstand inevitable careless handling of heavy clamshell unloaders.

The open hopper, of course, is suitable for carrying any other materials or commodities not requiring protection from the weather, either in bulk or manufactured, as clay products, brick and tile, structural steel and machinery, lumber, ore, stone, etc.

The form of the barges, in section, thus given by the hopper, is that of two side pontoons, each 6 ft. wide by 10 ft. deep, connected by a double bottom 36 ft. wide by 5 ft. deep, and in the bottom and pontoons, which latter act also as expansion tanks, there is stowage space for 1500 tons of oils or nearly 2000 tons of bulk molasses "blackjack" now beginning to move to this country from the West Indies via New Orleans. Liquid cargoes are to be loaded and discharged by a 6-in. pipe system, with suction and discharge valves in each barge compartment, operated independently by a large steam pump, and also by hand pumps, installed in one fore peak of the barge, steam supply being had from the towboat or from steam plant on the loading or discharging dock. The pipe system can be used also as a bilge system.

In addition there is a smaller pipe system, with fusible plugs and nozzles, passing under deck for steam supply to each compartment for fire smothering, and the compartments are entered through water-tight deck hatches, fitted with ladders, and are vented for oil evaporation by goose-neck pipe vents through the decks of the side pontoons close to the hopper combing, the mouths of the vents being carefully screened by fine-mesh copper netting, and closed against water ingress by balsa wood ball float valves soaked in linseed oil and varnished to prevent weather checking.

The barges are fitted at each end with hand capstans, hawsers, steel anchor cable, cable reels and stoppers, heavy stockless anchors handled from davits with blocks and falls, towing bitts and numerous kevels, chocks, side fenders, etc.

The straight body of the barge is about 168 ft. in length, the ends are alike and each, with long, easy rake of 42 ft., is molded for 66 ft. in length, with about 1 ft. sheer, and forms a spoon-shaped bow, giving remarkably easy lines and resultant least resistance to towing, yet the block coefficient of form was kept above 80 per cent, giving large displacement and capacity. The loaded economical speed is calculated at 5¼ m.p.h., and at this speed and 3½ ft. draft the resistance was found on trials to be only 1.7 lb. per ton of displacement (total weight of barges and cargo, 1200 tons), or fully one-third less than the resistance of standard short-rake, scow-bowed barges.

Owing to the great combined width of bottom (144 ft.) of a tow of three barges, with attendant heavy "drag" over shoal water, they are fitted with short wooden swinging side fenders in order to spread them slightly apart, thus offering spillways between the vessels, and for further relief, escape of drift, etc., the bilges are rounded with 5 ft. radius below the average draft line.

The barges are divided by 12 cross-bulkheads, and 1 central longitudinal bulkhead, or keelson, between bottom and hopper, into 2 fore peaks and 22 water- and oil-tight compartments, each controlled, as stated, by pipe lines and valves, vents, hatches, etc. Each barge when empty weighs about 550 tons, on 19½ in. draft, and the average cost at prevailing high prices is about $110,000 per barge.

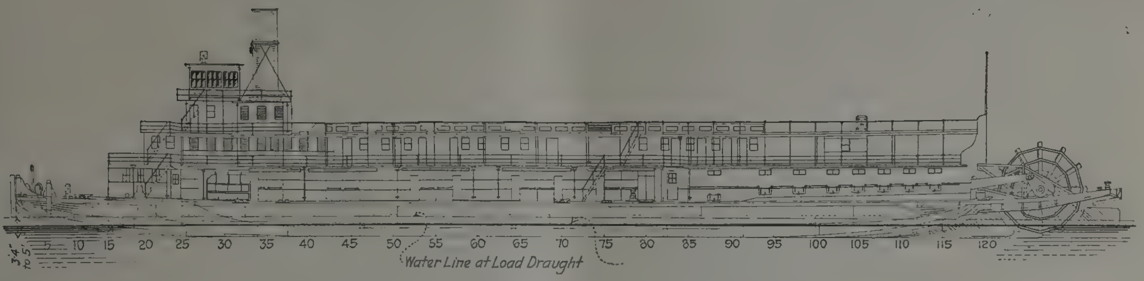
The barges have been constructed under separate contracts at three yards. They have been largely "fabricated" in the contractors' and associated shops, from templets taken from full-size mold lines, the fabricated parts being then erected on the launching ways. At this writing seventeen barges have been launched and completed, and the remaining two are expected to be finished in June.

DESIGN AND CONSTRUCTION OF TOWBOATS

The design of the towboats presented a problem even more complex than that of the barges. The power required to move a unit tow of three fully loaded barges, carrying 7500 tons of freight, upstream against the strong current of high water, is about 2000 hp., a greater power than has been heretofore provided (or developed) on a river towboat, yet the great weight of such a power installation, had to be mounted upon a hull of very light draft necessitated by the shallow depths at low water stages of the river. Nor can boats, as can barges, utilize fully in draft even the meager depths thus offered, but require, especially at the stern, a marginal or surplus depth below the hull to insure vitally essential backing power and maneuvering ability obtained by throwing the race water from the wheel under the hull. This requirement limited the low-water draft of the boat to slightly less than 4 ft. at the bow and about 3 ft. at the stern, but as these extreme conditions obtain only during the low-water season, with its greatly reduced currents and necessarily lighter loading of the barges, the full power of the wheel is not then required to be developed, and also the fuel supply to be carried may be greatly reduced, these conditions aiding to secure the lighter draft desired. At high stages the increased quantity of fuel to be carried, and possibly some water ballast in hull compartments provided therefor, can be relied upon to increase the draft 18 in. and 12 in., respectively, at bow and stern, and thus secure at will wheel immersion sufficient to develop the full power of the propelling machinery.

Three types of towboats and propelling wheels and appropriate machinery were considered; namely, hull with twin screw propellers in tunnels; side-wheel towboats; and the stern-paddle-wheel towboat of western river type, which was found to best fulfill the exacting conditions of the service planned. Objections to this type were the great overhanging weight of the paddle wheel, making difficult the fore-and-aft trim of the hull, and its rather inferior steering-ahead qualities as compared with side paddle wheels or twin screws; but its great backing and "flanking" (backing with strong sidewise movement) power give it unquestioned superiority over the other types.

The selection of the proper type of paddle wheel was also important. The radial fixed paddle wheel was chosen because of its simplicity of construction, ease of repair and, as compared to other types, light weight. The wheel designed probably will be one of the largest that has ever been installed in a stern-wheel towboat. While it weighs less than 60 tons, it will nevertheless



PROFILE, TOWBOAT FOR UPPER MISSISSIPPI RIVER.

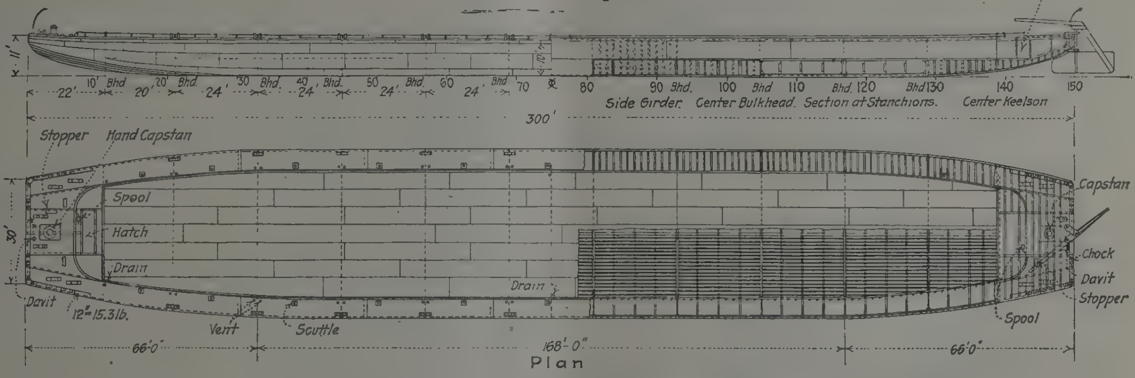


FIG. 1.—GENERAL PLANS OF UPPER MISSISSIPPI RIVER OPEN HOPPER TYPE BARGE. LENGTH OF HOPPER, 256 FEET; WIDTH OF HOPPER, 36 FEET.

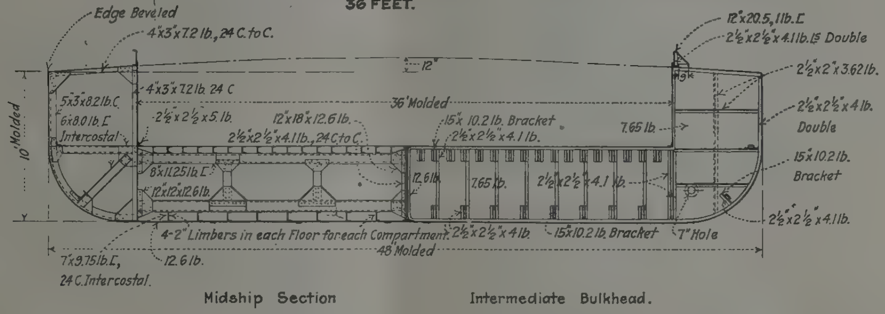


FIG. 4.—MIDSHIP SECTION OF OPEN HOPPER TYPE BARGE FOR UPPER MISSISSIPPI RIVER

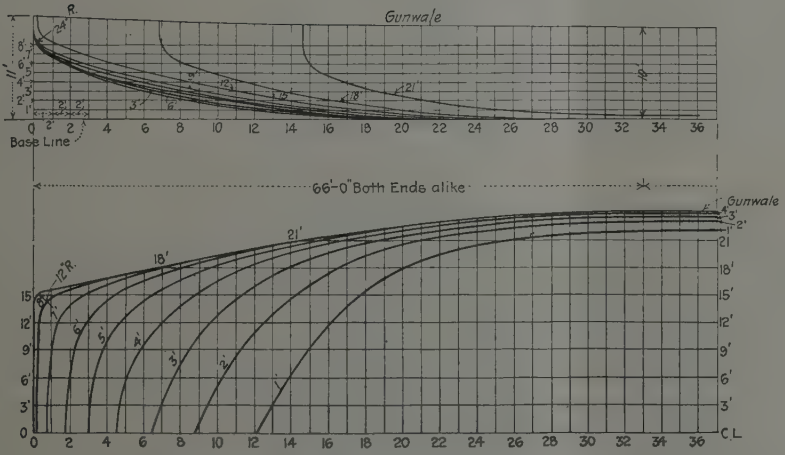


FIG. 2.—MOLDED LINES OF UPPER MISSISSIPPI RIVER BARGE.

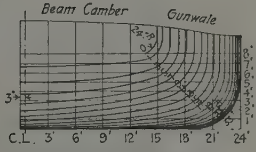


FIG. 3.—BODY PLAN OF UPPER MISSISSIPPI RIVER BARGE.

be 22 ft. in diameter with 12 wooden paddles, each 40 ft. long by 3½ ft. wide, borne on 7 wheel flanges. The r.p.m. will be 22 to 25, to develop the full power of thrust of 50,000 lb. required. The shaft will be of forged nickel steel, carefully annealed and machined to dimensions. It will be 46 ft. 2 in. in length, 25 in. outside diameter, but with 7 octagonal seats on which the wheel flanges will be keyed, hollow-bored to 19 in. diameter, with the ends reinforced interiorly and integrally to 6 in. thickness under the crank grips and journals, tapering into 3-in. walls under and between the outside flanges.

The engines are twin tandem compound condensing, 24-in. high-pressure and 48-in. low-pressure cylinders, and 8 ft. stroke, and are designed for an initial pressure of 250 lb., with steam superheat of about 75 deg. In order to carry the great weight of the engines well forward of the stern of the boat, they are fitted with 2 sets of pitmen, crossheads and slides, separated by about 17 ft., an arrangement which has been tried recently with success on other government boats in the St. Louis District. The surface condenser is of usual type and has 3000 sq. ft. of cooling surface.

The boilers on each boat are two in number, of Heine crossdrum marine type, with 3½-in. tubes 14 ft. long; each boiler having 4250 sq. ft. of heating surface, 100 sq. ft. grate surface, and with stack superheater (Foster type) and feedwater economizer, fan blower leading directly above to an individual stack and with turbine forced draft in the furnace which is fitted with grates for coal fuel, but arranged also for ready installation of burners, air preheaters, etc., for oil fuel, as it is highly probable that tar fuel, which can be obtained from local coking plants, will be carried in the oil compartments in the hull.

The auxiliary machinery will include heavy steam capstans, hand capstans, settling tanks and neutralizing and clarifying plant for boiling water, domestic water supply, electric-lighting plant, refrigerating plant, steam steering engines and gear, oil and bilge pipe lines and the usual feed, fire and deck pumps, injectors for emergency boiler feed, coal-handling apparatus, machine tools for repairs, motor-boat tender for sounding, etc.

The hull will be fitted with a heavy steel spud and hoisting engine, as for a dredge, for anchoring the boat and tow and to afford a firm anchorage against which to pull to release barges grounded on the shoals, which so frequently happens in all shallow rivers.

Also, each boat is equipped with two sets of balanced rudders, one set of 4 rudders fitted, as usual, at the stern transom, forward of the wheel, and the other set of 2 rudders fitted aft of the wheel, each set acting alternately in the strong race water from the wheel when backing or going ahead, respectively, the double installation greatly increasing the steering and maneuvering power of the craft.

It was originally planned to install towing engines and tow barges behind the boat on cable hawsers as done in Europe, especially when running through narrow bridges, but on account of the expense of installation these engines were omitted, as were also the large rudders necessary for such towing. However, the foundations for the engines on the towboats and the rudder attachments on the barges were retained, and in future, if desired, the remainder of the required astern towing plant may be installed.

Each hull for all this machinery is 230 ft. long, 58 ft. beam and 8 ft. deep, and will displace about 1100 tons when under steam. As in the barges, so also in the boat hulls the sunken deck is used, forming a hopper 3 ft. deep from the boiler room nearly to the after transom, thus lowering the height of the deckhouses and reducing the wind surface of the boat, which will aid greatly in maneuvering heavy tows through the bridge spans, narrow channels and shoal water to be encountered. The deckhouses and accommodations also are of steel, and fireproof as far as is possible without undue weight.

A novel feature of the hull construction will be stiffening and strengthening trusses on each side running from the boilers to the wheel beams aft of the shaft, supporting the wheel and also supporting on the upper chords the entire steel middle deck (and superstructure), which thus incorporated into the top members of the trusses becomes an important component in the longitudinal strength of the boat.

Each boat will be completely outfitted for a full crew of 40 men, and will cost about $375,000 when complete, outfitted and turned over to the lessee.

Fabrication for all the boats is now well advanced and the erection of two hulls at Stillwater is progressing rapidly. It is expected that both will be in operation during the coming fall season, and that the remaining two will be ready by next spring.

OTHER RIVER FLEETS

As a reflex of this attempt to stimulate and revive commercial navigation on the upper Mississippi River, a similar movement was at once started to utilize the lower Mississippi River between St. Louis and New Orleans for general commercial transportation, and the United States Railroad Administration furnished funds to construct a fleet of 6 towboats and 40 large—2000-ton—barges, fitted with steel protective deckhouses, for that service, but without awaiting the construction of these vessels the Railroad Administration began operations in the summer of 1918 with a fleet of vessels obtained by purchase and lease from private and governmental owners. The new fleet is under construction, a number of the barges already have been delivered by the builders, and one of the towboats is soon to be in operation. The barges are of the scow-bow type and the boats are of the tunnel twin-screw type and about 1500-hp., that type being chosen for the boats as the low-water channel depths in the lower river are thought to be sufficient for such craft. It is expected that interesting comparison of the relative efficiencies of the two types of towboats and barges in the two river sections may be made after one or two years of operation.

The Great Warrior River also is to have a fleet of power barges now building as another of the sequelæ to the upper-river revival; and numerous inquiries from individuals and corporations indicate that many private barge and steamboat lines may be expected as the success of the Government lines becomes apparent.

TERMINAL FACILITIES

As a result of widespread and searching public discussion and of investigations by the War Department, covering the entire field of transportation, it was early seen that modern, up-to-date docks and terminal facilities, warehouses and yard trackage, all equipped and arranged for convenient, quick and economical interchange of freight between water and rail carriers, are essentially, almost vitally, necessary adjuncts to successful and effective use of the rivers.

In promotion of such facilities a circular letter was issued in October 1917 by the Board of Engineers for Rivers and Harbors (advisory to the Rivers and Harbors Committee of the House of Representatives in Congress), which was distributed by the War Department to all municipalities concerned, calling upon cities and towns located on navigable streams to construct and maintain proper river terminals, open to all on equal terms, as a prerequisite to further appropriations for river improvement, and in encouragement of a revival of river-borne traffic. In response thereto the cities on the Mississippi River and its tributaries, generally speaking, have made earnest efforts to comply by planning and arranging for terminals and wharves to such extent that every important city on the river between St. Louis and Minneapolis, and on the Illinois River, has either built terminals or has prepared financially to do so, as necessity therefor arises. Particulars of these developments are given in the complete paper. This indicates an intense public interest in the question of river traffic, as, practically, commercial navigation on these rivers is now at its lowest ebb.

In the foregoing sketch of that part of the present active effort to revive water transportation, possibly centering at St. Louis and on the Mississippi River, may be seen the very general public interest in the use of the river, and it is hoped that the seed sown by the Government in its aid to the movement may have fallen on fertile ground and will return the economic relief and harvest for which the Mississippi Valley has hoped so long.

Superchargers for Airplane Engines

The Necessity for Supplying Air to the Carbureter at Sea-Level Pressure at High Altitudes—The Moss Supercharger for This Purpose, Its Design, Development and Performance

By SANFORD A. MOSS,[2] WEST LYNN, MASS.

An airplane flying at high altitude is in an atmosphere of comparatively low density. For instance, at 20,000 ft. altitude the density is practically half that at sea level. This means that a given volume contains half as much actual air by weight. The cylinders of an airplane engine are therefore charged with an explosive mixture which has about half the value of a charge at sea level. The engine actually delivers about half of its sea-level power at 20,000 ft.

Both the low temperature and the decreased pressure at high altitude have effect in fixing the high-altitude density. Both the decrease of temperature and the decrease of weight of the charge affect the carburation at high altitude. The fixed clearance volume and the decreased initial pressure give a decrease of compression pressure resulting in a loss of efficiency. There is, therefore, a combination of causes which gives as a net result a decrease in engine power very nearly proportional to the decrease in density.

At high altitude the resistance of the air to the motion of the airplane is decreased directly in proportion to the decrease of density. The power required for a given airplane speed is therefore greatly reduced. However, the engine power has been so reduced that the usual net result is a considerable decrease in airplane speed. When the engine power is maintained at the sea-level value, there is, however, a considerable increase of speed at high altitude.

Filling the cylinders of an internal-combustion engine with a charge greater than that which would normally occur, is called "supercharging." Methods of doing this have engaged the attention of a great many experimenters.

The centrifugal compressor is an apparatus similar to the fan blower except that the shape of the impeller blades and the passages leading air to and from the impeller are so arranged as to give an efficiency very much greater than that of the usual type of fan blower, so that the apparatus forms a satisfactory means for compressing air to appreciable pressures. A line of single-stage centrifugal compressors has been developed for compressing air from 2 to 5 lb. per sq. in. above atmosphere, to be used for many industrial purposes; as well as a line of multi-stage machines for compressing air and gas up to pressures of 30 lb. per sq. in. above atmosphere.

The turbo-supercharger is a combination of a gas turbine and a centrifugal compressor, arranged as part of an airplane gasoline engine. The hot products of combustion from the engine exhaust are received upon the turbine runner and furnish power whereby is driven a centrifugal compressor mounted on the same shaft, which compresses air for supply to the carburetors. A more detailed description is given later, as well as particulars regarding its development.

In the latter part of 1917 the National Advisory Committee for Aeronautics requested the coöperation of the General Electric Company in the development of the turbo-supercharger in the United States. Our work was originally started at the suggestion of Dr. W. F. Durand, then Chairman of the Committee, who knew of our long experience with gas turbines and centrifugal compressors. It has since been carried on under the supervision at various times of Col. J. G. Vincent, Col. T. H. Bane, Major H. C. Marmon, Major G. E. A. Hallett and Major R. W. Schroeder. Major Hallett has had charge of the development since the armistice, and he has given considerable study to the matter of superchargers in general.

The Turbo-Supercharger Cycle

Fig. 1 shows an airplane engine equipped with a turbo-supercharger. The exhaust of the engine is received by an exhaust manifold which leads it to a nozzle chamber carrying nozzles which discharge it on to the buckets of a turbine wheel. On the same shaft as this turbine wheel is the impeller of a centrifugal compressor. This compresses air from the low-pressure atmosphere to approximately normal sea-level pressure and delivers it to an air-discharge conduit which supplies the carburetors.

The turbine nozzles are of such area as to maintain within the exhaust manifold and nozzle box a pressure approximately equal to that at sea level. The difference between this pressure and the altitude low pressure gives a pressure drop for the exhaust gases which furnishes the power that operates the system.

Due to the respective temperatures this power input suffices to give the desired compression and also to supply the inevitable losses. However, in order to avoid back pressure on the engine, above the normal sea-level value, both turbine and compressor must be designed with utmost attention to efficiency.

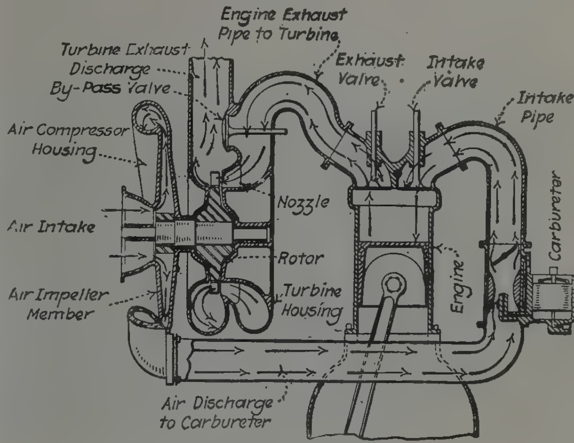


Fig. 1 Diagrammatic Sketch of an Airplane Engine Equipped with a Supercharger

With an efficient arrangement the engine when at high altitude exhausts at normal sea-level pressure and receives its air at the carburetor at normal sea-level pressure. Hence, normal sea-level power is delivered at all altitudes up to the maximum for which the supercharger is designed, so that the plane speed will increase uniformly as the altitude density decreases.

Mechanical Problems of Supercharging

The General Electric superchargers thus far constructed have been designed to give sea-level absolute pressure at an altitude of 18,000 ft., which requires a compressor that doubles the absolute pressure of the air. This pressure ratio, with the quantity of air involved, means about 50 shaft hp. input for the compressor. The design of a complete power plant of this size to suit an existing airplane engine, with such weight and location as will not impair the flying characteristics of the plane, has of course offered many problems. The possibility of driving the compressor of the supercharger by engine power instead of by the exhaust gases suggested itself. Much experience with the operation of the gas turbine, however, led the writer to prefer its problems to those of the driving mechanism of a supercharger operated from the engine. The turbine involves merely the addition to the compressor of a single extra wheel, designed for the conditions, with

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[1] Condensed from an article on The General Electric Turbo-Supercharger for Airplanes, published in the June 1920 issue of the *General Electric Review*, to which journal Mechanical Engineering is indebted for advance proofs of the article and for the illustrations here used.

[2] Engineer, Turbine Research Department, General Electric Co. Mem. Am.Soc.M.E.

no extra bearings. The engine-driven scheme involves a 50-hp. transmission with a multiplicity of gears, bearings, clutches, belts, and the like. These offer more or less drag on the engine when the supercharger is not in use at low altitudes, and very serious problems of acceleration when the supercharger is to be thrown into action, since the engine will be then running at its full speed of about 1800 r.p.m.

The exhaust manifold and nozzle box have proved to be a very efficient exhaust muffler and conductor. Such a muffler and conductor is needed in any event, and the design of means for withstanding the increased pressure difference of the turbo-supercharger has been successfully accomplished.

POWER FOR TURBO- AND ENGINE-DRIVEN SUPERCHARGERS

An efficient turbo-supercharger theoretically deducts from the indicated horsepower of the airplane engine an amount corresponding to the difference between sea-level absolute pressure and altitude pressure. There is this additional back pressure during the exhaust stroke. The theoretical power available for driving the turbo-supercharger is greater than this, however, owing to the fact that there is available not only the energy due to the direct pressure difference mentioned, but also the energy of perfect expansion from the higher to the lower pressure. If there were no turbo-supercharger the engine would waste this energy in sudden pressure drop as the exhaust valve opens. The turbine can utilize this energy. The sum of these two amounts of available energy, multiplied by the efficiency of the turbine wheel, gives the shaft power delivered to the compressor.

For an engine-driven supercharger compressor there is greater engine indicated power due to a lower exhaust pressure. However, the shaft power for the supercharger compressor must be transmitted through the engine connecting rod and crankshaft, with losses, and then through the supercharger driving mechanism with additional losses. The total shaft power thus subtracted from the engine, multiplied by the efficiencies of these two transmissions, gives the shaft power delivered to the compressor. This is the same as for the turbo-supercharger. For a Liberty motor of about 400 hp. and sea-level power at 18,000 ft. altitude, this power is 50 hp.

The comparison then is as follows: The turbo-supercharger subtracts from the engine indicated power, adds power of expansion which would not otherwise be used, and has turbine wheel losses. The engine-driven supercharger puts this indicated power through the engine (with some additional loads on the pins and bearings) and has engine and transmission losses.

With usual efficiency there is probably not a great difference between the gross subtraction from engine power in the two cases. There is then the disadvantage of transmitting the supercharger power through the engine pins and bearings, as well as through some mechanism between engine and supercharger, to be compared with the collection of the hot gases under pressure (with muffling advantages) and delivery to the turbine wheel. As already mentioned, practical success to date is in favor of the turbo-supercharger and the writer feels that this is really due to its innate superiority.

Engine-driven superchargers with positive-pressure blowers have been proposed. These have the additional disadvantage that with the desirable pressure ratios of about two to one there is an appreciable compression loss due to the fact that the machine only displaces air and has no direct means for compression.

Supercharging engines of various kinds, in which the engine crankcase or the engine cylinders themselves are arranged for additional compression, have been shown to give excessive weight and complication as compared with a turbo-supercharger.

DEVELOPMENT OF THE TURBO-SUPERCHARGER

The machines used thus far have been designed to give sea-level pressure at 18,000 ft. altitude, which corresponds to a pressure ratio of about two. The rated speed for these conditions is 20,000 r.p.m. Sea-level pressure has readily been obtained up to 22,000 ft. altitude. The control is entirely by hand operation of waste gates, which permits of free escape of some of the exhaust gases.

The entire apparatus, exclusive of exhaust manifold and air-discharge conduit, weighs about 100 lb. The exhaust manifold and air conduits have nearly the same weight as equivalent parts with no supercharger.

The turbine and compressor wheel have diameters somewhat less than a foot. The present design has been hampered by necessity for accommodation to existing engines and planes. It is proposed, however, to construct apparatus in which engine and supercharger are integral, with all parts arranged for the full possibilities of the combination.

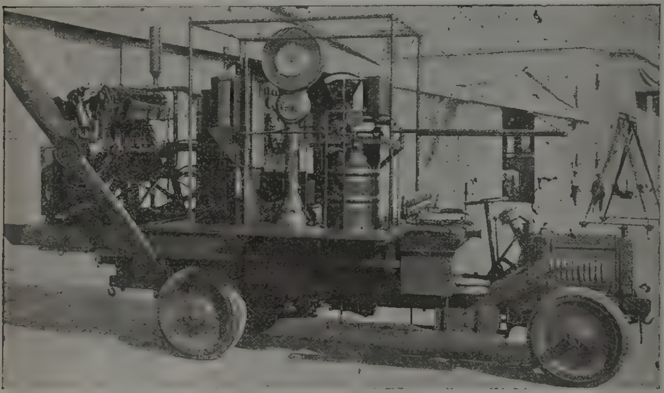

FIG. 2 MOTOR TRUCK PREPARED FOR EXPEDITION TO SUMMIT OF PIKE'S PEAK FOR TESTING LIBERTY MOTORS

FIG. 3 SHOWING WAY IN WHICH MOTOR TRUCK OF FIG. 2 WAS LEFT AFTER END OF DAY'S WORK

In the combination under consideration the airplane, propeller, engine, radiator, cooling system, and supercharger are so intimately associated that no adequate tests can be made without the complete system in operation at full speed at altitude. During the initial development of the Liberty motor a testing expedition had been sent to the summit of Pike's Peak, and it was decided to repeat this performance with the supercharger. Fig. 2 shows the motor truck that was prepared for the expedition and Fig. 3 the way it was left after each day's work. The Liberty motor carrying the supercharger was mounted on a cradle dynamometer, with scales and all arrangements for accurate measurement of power, gasoline consumption and the like. In fact, a complete testing laboratory was provided. The motor truck was shipped by rail to Colorado Springs, and then proceeded by its own power to Pike's Peak summit on the "Pike's Peak Auto Highway," a well-constructed but very tortuous mountain road 28 miles long. The summit has an altitude of 14,109 ft. and it is the highest point in the United States easily reached by road.

The testing work at the summit lasted through September and half of October, 1918. The usual difficulties with experimental work were, of course, encountered with the addition of many delays, due to the cold and snow, and distance from repair shops. The apparatus was finally arranged to give good mechanical operation and it was found possible at the existing altitude of 14,000 ft. not only to supercharge so as to give full sea-level power, but also to overcharge so as to cause the engine to preignite.

It was agreed that results of the tests warranted the immediate installation of the supercharger on an airplane, and arrangements for doing this were in progress when the armistice caused a cessation of the work. After the armistice, careful reëxamination of the situation resulted in resumption of the work in the early part of 1919. Various rearrangements were made in view of the experience gained at Pike's Peak and the apparatus was finally installed on an airplane.

It soon developed that a very appreciable increase of power was easily obtained when the supercharger was opened up. The whole airplane installation was not properly arranged to take advantage of this power, however, and changes were necessary in the radiator, cooling system, propeller system, gasoline tank, pump system, etc. Changes in these parts have been made from time to time, and this work is still in progress. As the work proceeds more and more power is developed by the engine. Changes have also been made in the supercharger itself.

Fig. 4 Right to Left: Major R. W. Schroeder, Lieut. Geo. W. Elsey and Dr. Moss

Fig. 4 shows Major R. W. Schroeder, who has made all of the flight tests to date, together with Lieut. George W. Elsey, who has made all of the flight observations to date. The aviators are of course clothed for the intense cold of high altitudes and carry the parachutes that are now regularly used by the U. S. Air Service in experimental work.

Supercharger Performances

The supercharger which has been used to date was primarily desired for high speeds at altitudes of 18,000 to 22,000 ft. The Le Pere plane on which the installation was made had a ceiling of about 20,000 ft. with two men, and a speed at this altitude of 70 miles per hour. With the supercharger in use, a speed of about 140 miles an hour has been attained at 22,000 ft. As already pointed out, this has been attained with various parts of the plane installation in a partially developed state. Theoretical computations have been made showing that much higher speeds at high altitudes are to be expected, and the flight tests to date indicate that the theoretical expectations will be fully realized.

The making of high altitude records has been very attractive and the supercharger has, of course, been used for this purpose as well as for the speed courses mentioned. Successively higher altitudes have been reached as experience has been gained regarding the manipulation of oxygen, gasoline, and other details.

On February 27 Major Schroeder made a flight alone, attaining an actual height above the ground finally computed as 36,130 ft. (6.85 miles). The lowest temperature reached was minus 67 deg. fahr. At the maximum altitude his oxygen apparatus failed and he became unconscious and lost control of the plane, which fell almost vertically. As he neared the earth he partly recovered consciousness and, at an altitude of about 3000 ft., succeeded, in a half-dazed semi-automatic way, in righting the plane and making a good landing in his own field, again becoming unconscious. He was taken to a hospital in a serious condition, but has since almost completely recovered. The supercharger, engine, and plane were in perfect working order after the flight.

At the maximum altitude attained, recording instruments showed that the plane was still climbing at the rate of about 125 ft. per minute and it was estimated that an altitude of 40,000 ft. would have been attained if the oxygen apparatus had not failed.

[In the May issue of the *General Electric Review* there also appears a reprint of a paper on Superchargers and Supercharging Engines, by Major George E. A. Hallett, U. S. A., presented at the annual meeting of the Society of Automotive Engineers, January 7 and 8, 1920. Major Hallett, who is Chief of Power-Plant Division, U. S. Air Service, deals at some length with the various methods employed in supercharging and refers to the work of the U. S. Air Service on the Rateau type of turbo-compressor, under the supervision of Mr. E. H. Sherbondy, prior to that undertaken by Dr. Moss. Commenting on the working of the Moss supercharger, he says:

> It would naturally seem at first thought that the extremely low temperatures always found at great altitudes would make possible the easy solution of cooling problems, but in reality the low density of the air reduces its heat conductivity and capacity for heat absorption to such a point that a supercharged engine developing sea-level power at 20,000 ft. requires a little *more cooling surface* than it does when developing normal power at sea level.
>
> The Liberty engine and many others run best with a water temperature of about 170 deg. fahr. To maintain the cooling water at this temperature in the reduced atmospheric pressure at 25,000 ft. it is necessary to use several pounds of air pressure in the radiator to prevent the water from boiling away. Very effective radiator shutters are needed when the engine is throttled to make a descent from altitudes of over 20,000 ft. to prevent the water in the radiator from freezing before warmer air is reached.
>
> Contrary to expectations, the Moss turbo-compressor now being tested at McCook Field does not complicate the pilot's controls. On a normal engine the pilot handles the throttle and the altitude carburetor control which thins down the mixture as he ascends. With the turbo-compressor the altitude control becomes unnecessary up to the altitude at which the engine can no longer deliver sea-level power but is used, as with a normal engine, if the plane is driven higher.

As to the future of the supercharger, Major Hallett says:

> The uses of the supercharger for military service can be divided into: first, for airplanes in which it is desired to reach extreme altitude; second, for airplanes in which it is desired to increase the rate of climb and horizontal speed and therefore maneuverability at altitudes where it is intended to fight; and, third, for airplanes which carry large loads such as bombers, which normally are handicapped by having a very low ceiling and whose entire usefulness would, if larger engines were installed to pull them to a higher ceiling, be lost on account of the large amount of fuel and other material that would have to be carried, thus decreasing their radii of action.
>
> In the first case it is believed that a special supercharger can be built that will make feasible much greater altitudes than any that have been attained with the present General Electric turbo-compressor; and it is considered essential that we have airplanes capable of reaching very great heights. In the second case, it is pointed out that military machines not fitted with supercharging engines, when fighting at an altitude of 20,000 ft. or more, are so near their ceiling that their rate of climb, speed, and maneuverability are comparatively poor, but the use of a supercharger seems to overcome this difficulty easily.
>
> The use of superchargers in commercial airplanes of the future is assured because superchargers will make possible far *more miles per hour* and *more miles per gallon* with a given engine and airplane, and speed is the main advantage of air over other kinds of transportation. It is thought by many qualified judges that by flying at a sufficient height with a supercharged engine and a suitably designed airplane, a speed of 200 m.p.h. can be maintained.]

Spring Meeting of The American

Whole-Hearted Hospitality Extended by St. Louis—Engineers Present From Many Sections
Professional Sections Started—Discussion of Local Engineering Problems
Joint Session With Society of Refrigerating Engineers

THE 1920 Spring Meeting was the first convention of the Society to be held in St. Louis in twenty-four years and so open-hearted was the hospitality, so well carried out were the excursions and entertainments, and so thoughtfully was every detail worked out for the comfort of the guests that every member in attendance enthusiastically demanded an early repetition of a St. Louis Spring Meeting. It was successful in every phase, as in addition to the social features the professional sessions were well attended and pertinent discussions contributed.

The meeting gained momentum quickly, the business session starting promptly at 2 p.m. on Monday, being followed by the professional sessions as scheduled. The total registration was 475 members and 330 guests, most of whom arrived for the first session and remained to the end. All of the professional sessions were held at the Hotel Statler, the headquarters of the meeting.

Opening Reception

On Monday evening a reception for visiting members was held in the Hotel Statler. Clarence H. Howard, president of the Commonwealth Steel Company of St. Louis, extended a warm welcome and spoke about the development of the Junior Chamber of Commerce and the importance of business training for young men and boys. President Miller responded with the thanks of the Society for the hospitality shown up to that time and anticipated during the remainder of the convention. He also spoke of the problems in industry and earnestly pleaded for closer coöperation between workmen and managers. Mr. E. R. Jackson displayed several reels of the official moving-picture record of the First Transcontinental Motor Convoy. The pictures were accompanied by comments from Mr. Jackson on the various events taking place on the trip, and were received with interest and close attention. Mr. L. C. Nordmeyer, chairman of the St. Louis Section, presided at this meeting. The members of the St. Louis Section proved delightful hosts and everyone thoroughly enjoyed the dancing which followed.

Entertainment

The Spring Meeting banquet, held Tuesday evening, May 25, in the large dining room of the Missouri Athletic Association, was attended by over 700 members and guests. A fine musical program was presented during the dinner, after which Lt.-Col. H. W. Miller, of the Ordnance Department, presented a paper on the German Defenses on the Coast of Belgium. Colonel Miller's paper, which appeared in the June MECHANICAL ENGINEERING, is a valuable contribution to the information necessary for the solution of the coast-defense problem of this country. The very formidable fortifications thrown up by the Germans on the coast of Belgium kept the Allied fleets at bay for three years and the lessons that may be learned from this paper are of great interest to every one who understands the great problem before the War College in the selection of proper methods of coast defense.

A special entertainment for all engineering societies holding meetings in St. Louis and all members of St. Louis engineering societies was arranged at the beautiful new municipal open-air theater in Forest Park. The interesting program of music and interpretative dancing was presented from a picturesque natural stage, which, viewed from the outer circle of the amphitheater, gave an inspiring perspective of lights and color. St. Louis may well be proud of this concrete structure, holding 7000 people and having perfect appointments.

On Thursday afternoon the excursion steamer *St. Paul* was chartered for a boat ride up the Mississippi. This trip was a decided success in that it afforded a fine opportunity for making acquaintances and for that reason was voted the most successful entertainment of the meeting. Music and dancing were enjoyed on the boat.

The ladies attending the convention were particularly well taken care of and were afforded very interesting trips through the residential section, through Forest Park and visits to the Art Museum, Shaw's Garden, Washington University and to Brentmoor, Westmoreland and Portland Places.

Trips of Inspection

The trips of inspection planned by the St. Louis Committee covered a wide variety of industries and engineering works for the visiting members. On Tuesday afternoon the plant of the Commonwealth Steel Company at Granite City, Ill., was visited by a large number who were very much interested in the new methods shown for making steel castings. The 122,000-kw. plant of the Union Electric Light and Power Company at Ashley Street was also visited Tuesday afternoon, followed by a call at the docks of the St. Louis Boat and Engineering Company where steel barges are under construction for the United States Government.

Wednesday morning the trips included the plants of the General Motors Corporation, Wagner Electric Company, Evertight Piston Ring Company, and Heine Safety Boiler Company.

Society of Mechanical Engineers

of the Country — Members Enthusiastic and Meeting Pronounced a Great Success — Two Important Feature — Appraisal and Valuation Session Excites Interest — and Society of Heating and Ventilating Engineers.

Lunch was served at the Bevo Plant of the Anheuser-Busch Association, following which the party moved on to the works of the Busch-Sulzer Brothers Diesel Engine Company, the Mississippi Valley Iron Company, and the coke plant of the Laclede Gas Light Company.

PUBLIC HEARINGS

On Tuesday morning, May 25, at 10 a.m., the Committee on Protection of Industrial Workers opened to public discussion the Elevator Code covering the construction, operation and maintenance of elevators, dumbwaiters and escalators. Many useful criticisms and suggestions were advanced which will be considered in the work of the Committee. At 2 p.m. on Tuesday the Boiler Code Committee held a public hearing on the Rules for Air Tanks and Pressure Vessels. At this session the discussion centered largely on the value of welding the seams of the vessels under consideration.

KEOKUK EXCURSION

Eighty members of the Society availed themselves of the opportunity to inspect the hydroelectric developments of the Mississippi River Power Company at Keokuk. The special cars arrived at Keokuk Sunday morning and were met by representatives of the Power Company and after an Iowa breakfast the party was split up into small sections which were effectively guided across the locks and docks to the power house and dam. Every detail was explained carefully and with consideration by the power-house attendants. Mr. L. E. Dickinson was in charge of the plant for the day and to his courtesy and thoughtfulness the success of the excursion was undoubtedly due. After the power-house inspection the party motored about the adjoining country and after dinner went aboard the sleeping cars and arrived at St. Louis on Monday morning.

TULSA TRIPS

Following the meeting in St. Louis, about fifty of the attending members left for Tulsa, where, Friday and Saturday, a joint meeting of the Mid-Continent section of The American Society of Mechanical Engineers was held with the Oklahoma section of the American Chemical Society.. A full account of this meeting and the trips in connection with it is given elsewhere in this issue.

LOCAL COMMITTEES

The entire arrangement for the entertainments, excursions and publicity for this meeting was under the jurisdiction of the General Committee, the personnel of which was as follows: M. L. Holman, Hon. Chairman; Louis C. Nordmeyer, Chairman; Lewis Gustafson, Vice-Chairman; Fred. E. Bausch, Secretary; William P. Samuel, Treasurer; Ernest L. Ohle, H. Wade Hibbard, Chester B. Lord, Edward W. Schadek, Victor J. Azbe, and Edward R. Fish.

Emphasis must again be placed on the hospitality extended by the St. Louis Section and the thoughtfulness with which every detail was worked out. The work of the Women's Committee, of which Mrs. Ernest L. Ohle was chairman, in anticipating every desire of the wives of the visiting members and guests was particularly noteworthy.

In the publicity work the St. Louis Convention and Publicity Bureau was very helpful and its representative, Mr. Francis E. Turin, worked in very close coöperation with the Committee.

Business Meeting

THE matters coming before the business meetings of professional societies are often regarded by the members as uninteresting. However, at the semi-annual business meeting in St. Louis, held on the Monday afternoon, the attendance was quite large and the discussion general, indicating a good interest in the various details presented for consideration.

Vice-President Fred R. Low opened the meeting, and after a few minutes President Miller took the chair and introduced the subjects of the meeting.

The first business presented by the Secretary was the report of the Tellers of Election, John H. Lawrence, Mancius S. Hutton and R. K. MacMaster, on amendments to the Constitution. This report was adopted on the motion of Mr. Low and the amendments declared carried. They provided for

a Addition of Standing Committee on Professional Sections.

b Approval or adoption of reports, standard formulæ or recommended practices.

c Termination of membership on the Council or any committee on account of absence.

The amendments were published in MECHANICAL ENGINEERING, January, 1920, p. 33.

Mr. H. J. C. Hinchey then presented the report of the Special Committee on Code of Ethics. This report with the Code incorporated in it will be published in MECHANICAL ENGINEERING. The report was referred to Engineering Council or to such organization as may be formed for joint action by the Engineering Societies on matters of common interest to form the basis of a possible general Code of Ethics. The Committee was continued to take such action as might seem advisable looking toward the adoption of a Code by the Society in case no other suitable action was taken.

A report of the Boiler Code Committee on Boilers for Locomotives was presented by title and those interested were referred to a special session held for its discussion.

Under new business President Miller introduced an amendment to the Constitution shortening the time required to complete amendments to the Constitution, which was discussed but no modification made. This amendment will follow the usual procedure.

The question of coöperation by the Society with the National Public Works Department Association was introduced and discussed, and the next day the following resolution was passed indorsing this movement:

WHEREAS: The American Society of Mechanical Engineers believes thoroughly in the principles of functional organizations and its members, as engineers, are particularly concerned with reorganizations leading to the substitution of efficiency and economy for looseness and waste, therefore, be it

Resolved: That The American Society of Mechanical Engineers in convention assembled fully indorses the effort which the National Public Works Department Association is making to achieve these results and specifically urges upon its local sections that in conjunction with the Local Engineering Societies these sections support this movement fully and effectively.

PRESENT AGE - 1920	AGE AT WHICH ELECTED TO MEMBERSHIP																														
AGE	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	Total	Per Cent
21	15																													15	0.5
22	33	26																												59	2.0
23	19	44	46																											109	3.7
24	20	37	70	38																										165	5.6
25	32	42	55	92	39																									260	9.0
26	11	38	72	69	83	50																								323	11.1
27	3	22	50	81	62	79	26																							330	11.2
28	6	12	28	40	84	73	50	5																						292	10.2
29	1	13	39	42	49	62	47	41	12																					306	10.6
30		3	16	35	40	53	54	26	34	9																				270	9.4
31	1	1	6	21	30	28	43	27	16	6	1																			180	6.2
32	3		4	10	16	23	19	18	25	4	11	3																		136	4.7
33		2	4	6	12	11	23	7	24			3																		93	3.1
34		3	3	5	5	10	11	20	8	1	1	1	6	4																78	2.7
35		2	2	5	2	3	9	13	20			1	2	3																62	2.1
36		2	2	4	4	5	1	8	7	1		1	2	3	1	2	1													44	1.5
37	2	1		4	5	5	6	5	4	2	1					1														36	1.2
38	1	2	2	1	2	3	2	3	3								2													20	0.7
39	1	1	2	1	1	4	1	3	1							1														16	0.5
40					2	5	2	1			1						2													13	0.4
41	1					1	4	1		1																				8	0.2
42			1	1					1		1	1																		5	0.1
43					1	2	1	1	1		1																			7	0.2
44		1		2	1		1		1				1											1						8	0.2
45						2	1	2		1	2	2													1					11	0.3
46						1	1	1		2	1		1										1							8	0.2
47						2	1	1		1		1		1												1				8	0.2
48			1		1																				1					3	0.1
49	1	1	1			1	2	1																						7	0.2
50																													1	1	
51					1		1			1																				3	0.1
52																															
53					1		2								1			1												5	0.1
54		1							1							1		1												4	0.1
55							1																							1	
56																															
57																															
58																															
59																															
60																															
61																															
62															1															1	
Total	150	255	404	457	441	423	309	184	158	29	20	13	12	11	3	5	5	2					1	1	2	1			1	2887	
Per Cent	5.2	8.8	14.0	15.9	15.2	14.8	10.4	6.4	5.5	1.0	0.7	0.4	0.4	0.3	0.1	0.1	0.1														100

STATISTICAL ANALYSIS OF AGE DISTRIBUTION

JUNIOR MEMBERS

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

MAY 1, 1920.

	Arithmetic Average Age	Median Age	Modal Age
With respect to age at which elected to membership	25.1	26.4	25.0
With respect to present age	28.8	27.6	27.5

(Number of college or technical school graduates 2184 or 75.3 per cent)

Age not indicated 15
Total [illegible] 2902

ANALYSIS OF JUNIOR MEMBERSHIP PRESENTED BY MR. M. L. COOKE AT THE BUSINESS MEETING

Mr. Morris L. Cooke introduced an amendment to the Constitution to extend the privilege of voting to Junior Members. He cited a resolution passed by the Philadelphia Section making such a recommendation. He quoted figures to show that the Junior Membership was approximately 23 per cent of the total and that that part of it below the age of twenty-seven was only 8 per cent.

Mr. Cooke also spoke of the necessity of affording proper outlet for the ideas and activities of the younger members and stated that the required combination consists of the sagacity and experience of the older men and all that young men give. Mr. Cooke's analysis of Junior Membership is shown in the above table.

The proposal was discussed by S. N. Castle, M. M. Case, H. B. Dirks, Max Toltz, C. B. Lord, J. H. Bernhard and J. M. Spitzglass, and Mr. Cooke's proposal was accepted by the meeting and his amendment will therefore go through the usual procedure.

At the adjournment of the business meeting the session on Appraisal and Valuation convened immediately.

Two Professional Sections Started

WELL-ATTENDED conferences looking to the organization of Machine Shop Practice and of Power Professional Sections under the new authority of the Council were held at the Spring Meeting, and at both of them the sentiment toward the organization of the sections was unanimous.

The Machine Shop Practice conference was held on the Monday morning and was called to order by Prof. H. P. Fairfield who was the Secretary of the former Sub-committee of the Meetings Committee on this subject.

The meeting instructed Professor Fairfield to appoint a committee of three to proceed with the organization of the section, and he selected R. E. Flanders, C. B. Lord and himself. The Committee met immediately and decided on a form of petition to the Council and reconvened the general session on the Wednesday when signatures to the petition were taken.

On the Monday the Council voted to refer this petition when received by the Secretary to the Executive Committee of the Council for action.

The conference on the Power Section was held on the Wednesday morning when Prof. R. H. Fernald, member of the Special Committee on Professional Sections representing this subject, called the meeting to order.

Practically the same procedure was followed as in the meeting of the Machine Shop Practice Section and Professor Fernald appointed F. R. Low, J. R. Bibbins, and A. L. Rice as the Organization Committee. This Committee drew up the petition and it has already been received by the Secretary and is being balloted on by the Executive Committee of the Council.

To date 350 members of the Society have registered in the new Machine Shop Practice Section and 850 members in the Power Section. Both of these Sections expect to conduct sessions at the forthcoming Annual Meeting under the auspices of the Committee on Meetings and Program.

During the discussion at these conferences it transpired that there was a little doubt as to the difference between a professional section and a professional session of a general meeting. The Professional Sections are intended to be organizations of a permanent character of groups of members of the Society who will devote continuous attention to their development of their subjects and will report either at Annual Meetings or at Local Section meetings or at meetings of their own or through the publications of the Society. Professional sessions at general meetings are simply divisions of the program of the professional papers presented to the Society determined upon by the Committee on Meetings and Program for convenience in conducting the Annual and Spring Meetings; the names of these sessions depending on the character of the papers on hand and the topics selected by the Meetings and Program Committee for the conventions.

ADVANTAGES OF PROFESSIONAL SECTIONS BROUGHT OUT

The organization of Professional Sections is a new one and it might be well to quote some of the views of the members expressed at the Spring Meeting on the development of the Society's work into this channel. Here are some of the opinions:

> There is great value in what we sometimes call "verandah talks" in little groups with no reporter present, and so long as we keep within the limits of the Society's activities prescribed by the Council, I see no harm in these.
>
> The Professional Sections will give the particular phases of engineering to which they are devoted more standing and dignity than was possible under the old arrangement of Sub-committees of the Meetings Committee.
>
> There are two tendencies in the Society: One is to narrow everything down to the purely technical, and the other is to open everything out to include general things of interest. The more we force ourselves into the narrow technical side of engineering the less good we will be to the community and the less influence we will have.
>
> This Professional Section movement is a very important one in the life of the Society, but we must guard against duplication of effort which will have a tendency to weaken what is destined to become a very important development.
>
> In the Professional Sections so far we are simply limited by the matter of expense. When that is overcome we shall have a perfectly free hand as to presenting papers and holding sessions at any time and anywhere in the country, with the restriction that if we desire sessions in the regular Annual and Spring Meetings, we must come on the regular program prepared by the Meetings Committee and do things under their instructions.
>
> The general idea prevails throughout the country that in order to get into The American Society of Mechanical Engineers one must possess a M. E. diploma or be a college graduate. This is not the actual requirement, but nevertheless the qualifications for membership are high. One object of the Professional Sections is to interest a number of men in the work who are not immediately eligible for membership in the Society, but who can join these Sections as Affiliates.
>
> There are a great many men in the country who know all about every phase of the work of the various Professional Sections being organized, but there are no organizations in their particular little fields which interest them. These men should be brought into our organization.

Members of St. Louis Local Committees, Whose Efforts Contributed So Fully to the Splendid Success of the Meeting

General Committee
M. L. Holman
Hon. Chairman
Louis C. Nordmeyer
Chairman
Lewis Gustafson
Vice-Chairman
Fred. E. Bausch
Secretary
William P. Samuel
Treasurer
Ernest L. Ohle
H. Wade Hibbard
Chester B. Lord
Edward W. Schadek
Victor J. Azbe
Edward R. Fish

Reception Committee
Roderick H. Tait
Chairman
A.S.M.E. St. Louis Membership

Women's Committee
Mrs. Ernest L. Ohle
Chairman
Mrs. Edw. R. Fish
Vice-Chairman
Wives of the Associated Engineering Societies Membership

Hotel Committee
William H. Reeves
Chairman
Joseph W. Peters
Vice-Chairman
E. Julius Boehmer
William E. Doll
Robert F. Wiselogel

Publicity Committee
Victor J. Azbe
Chairman
Edmond Siroky
Walter Siegrist

Finance Committee
Philip DeC. Ball
Chairman
John F. O'Neil
William M. Duncan
Hugo Wurdack
Louis C. Nordmeyer

Program Committee
Ernest L. Ohle
Chairman
H. Wade Hibbard
Vice-Chairman
Robert G. Clyne
Dwight T. Farnham
George S. Hessenbruch

Entertainment Committee
Fred. E. Bausch
Chairman
Frank N. Jewett
Arthur S. Hawks
Charles F. Frede
George B. Evans
Leonard A. Day
Stevenson A. Dobyne
Edward H. Tenney

Information Committee
Edward R. Fish
Chairman
Nathan Kohn
Fred Key
Lyman C. Huff
William A. Hoffman
Edward L. Dillon
Ray L. Howes

Transportation Committee
Walter E. Bryan
Chairman
James E. Allison
G. Horton Blackman
Franz A. Berger
Henry F. Gauss
Allen C. Staley
B. Frauenthal

Meetings and Program Committee in General Charge of the Society's Conventions

Dexter S. Kimball
Chairman
A. L. De Leeuw
W. G. Starkweather
R. V. Wright
J. W. Roe

Appraisal and Valuation Session

THE five papers submitted for this session had been previously contributed as discussion at the 1919 Annual Meeting and because of lack of time for complete consideration, it was decided to present the papers again at the Spring Meeting in 1920. The wisdom of this action was apparent from the interest shown and the value of discussion advanced. No agreement was reached as to methods of valuation and because of the grave importance of the subject to the engineering profession, resolutions were passed at the close of the Session which will keep the subject a vital issue before the Society.

This session, presided over by Dean Charles Russ Richards, Manager of the Society, was well attended and after three hours, was adjourned to the next day when, under the gavel of Vice-President F. R. Low, the discussion extended over two hours.

The session was opened by reading the following brief of Dr. David H. Ray's[1] paper on Appraisal and Valuation Methods:

> The outstanding feature of the paper is the method of integration of value by weighted average. This method cannot easily be applied by accountants because they do not know how to determine the coefficients.
>
> The second feature is the development of an "aleatory factor," which applied to modified original cost or reproduction cost, gives going value, must be based on the bed rock of theoretical economics and developed by experience and judgment in industrial engineering.
>
> The basic economics is contained in John Stuart Mill's Principles of Political Economy, volumes I and II, a striking paragraph being:
>
> > "The result of this long investigation may be summed up as follows. The economical progress of a society constituted of landlords, capitalists and laborers, tends to the progress enrichment of the landlord class; while the laborer's subsistence tends on the whole to increase and profits to fall."
>
> Normally by general economic law profits tend to become less, and laborers normally find themselves in a tighter position with the years, for subsistence; in other words the mechanism of fundamental world economics normally reduces profits and increases cost of living (and demands for wages).
>
> The way out of the dilemma is mechanical research and development. Here the skilled judgment of the industrial engineer comes into play and he must allocate the values and profits according to the various factors concerned in production and develop an aleatory factor which will differ with the class of business and its location.
>
> It is to be noted that accounting systems often carry land valuation at cost until sale or appraisal as our modern economic industrial line up tends broadly "to the progressive enrichment of the landlord class," this may or may not be a factor in fair valuation. It however requires consideration in the formulation of a just aleatory factor.

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[1] Professor of Industrial Engineering, California Institute of Technology, Pasadena, Cal.

In general therefore the determination of the aleatory factor is to be determined by an allocation of the elements of risk in the project considered along broad economic lines and modified by the special peculiarities of the business and its situation.

In presenting his paper on Price Levels in Relation to Value, Cecil F. Elmes[2] quoted John Stuart Mill's definition of value as "the value of a thing is its general power of purchasing, the command which its possession gives over purchasable commodities in general." Price he defined according to the New Standard Dictionary as "the amount demanded by an owner in return for an article as the condition of sale. . . . the quantity of labor which its possessor will take in exchange for it."

After showing the results of historical studies of commodity values and wages Mr. Elmes stated his conclusions as follows:

a It is of the utmost value to all of us and certainly to those engaged in the public utility business that precise use of the terminology of economics be insisted upon.

b Low commodity prices while superficially desirable may be in a broad sense the reverse of a blessing. Inasmuch as they signify a shrinkage in demand in commodity markets, they may be an indication of depression or stagnation in business.

c High prices—so long as they do not run into panic or famine prices—may equally be by no means an economic evil. Panic and famine prices are and should be within the control of the community and their evil effects can be largely eliminated by a wise use of that control.

d A great and progressive movement in the conditions of the laboring man is without question a large factor in the high prices of the present day.

e Every public-spirited citizen, having the welfare of the community at heart, and conversant with the evil of low wages, desires to see labor get just recognition and every incentive to progress and development.

f Outside of catastrophic disturbances which we cannot undertake to predict, a belief in lower commodity prices in the immediate future is hard to justify unless lower wages are taken for granted.

g The general laws of economics apply to public utilities just as much as to other lines of commerce, and every procedure and decision based upon the theory that economic laws apply to everything else except to public utilities is essentially unsound and vicious.

h In determining the rates of a public utility (and for that matter in any proceeding as between any two litigants before any tribunal) the word "dollar" should not be used to mean two different things, a high figure to one party and a low figure to the other party in one and the same controversy.

Rational Valuation—A Comparative Study, was the title of the paper presented by J. R. Bibbins[3]. The author called particular attention to the complex stage that the valuation problem had reached, and to the fundamental similarity between industries and utilities from the various aspects of valuating physical properties. He gave the results of an interesting historical study of an electric-railway property covering thirty years of the horse-drawn life, and its period of transition to electric propulsion up to the present day. This showed the rates earned over the period, the increase in net investment and the effect on deficit and surplus of varying rates of return. After considering the financial plans for rate-making purposes, and making a plea for a careful consideration of the present vague terminology of valuations, Mr. Bibbins closed as follows:

Is it not clear that the vagaries and inconsistencies of appraisal procedure could have been largely avoided thus:

1 By closer study of past history
2 Economic research into all fundamental facts
3 Reasonable forecast of future income and liabilities
4 More complete appraisal reports dealing with every aspect of reasonable value
5 An open mind—not trying to find the answer before we start
6 Acceptance of accrued depreciation as a physical fact to be handled like any other actuarial problem
7 Cost to reproduce theory used judiciously to reflect the original cost as nearly as possible
8 Institution of perpetual inventories and values based upon well-maintained and preserved records
9 Development of flexible or sliding-scale methods as bases for rates, service and return on investment
10 Adopting for utilities the practice of progressive industry in preserving its physical and economic integrity. Pay down "while the paying is good"
11 An attempt to educate rather than to obstruct or defeat Public Policy?

The paper entitled Data on the Cost of Organizing and Financing a Public-Utility Project, prepared by F. B. H. Paine,[4] was reviewed by Mr. Bibbins. Mr. Paine's paper presents the data accumulated in a report on a particular problem. He outlines the preliminary steps in the development of a public utility involving an expenditure of money. He analyzes these expenditures and upon the basis of his investigation concludes that the proper percentage for each of the following three heads is as follows:

The development of the project	2.5 per cent
The cost of money	5.0 per cent
The promoter's remuneration	5.0 per cent

Prof. H. C. Anderson[5] was unable to be present and his paper, The Construction Period, was also reviewed by Mr. Bibbins. This paper was presented to show in specific terms the relation of the construction period to the assignment of portions of construction cost known as overhead. These items of cost are items which must go into the property but which cannot be assigned as rails and ties are assigned. Professor Anderson's paper discussed proper allowance to be made for interest and taxes during the period of construction, items frequently ignored in early days of appraisal and too often exaggerated lately. His conclusion was that the proper interest charges can only be determined by a thorough study of the particular property under consideration with a view of determining: (1) The magnitude of the property, (2) the method used in finding the reproduction cost, (3) the proper construction period, and (4) knowing the construction period, what is the proper method to use. In determining the percentage to be allowed for taxes the author is of the opinion that the proper amount depends: (1) on the length of the construction period, (2) what percentage of the construction cost the assessor will find, and (3) the tax rate.

Mr. Elmes' paper was opened for discussion first and J. N. Chester,[6] commenting on the inflation of the dollar shown by Mr. Elmes, suggested that instead of attempting to change the valuations with corresponding changes in money value, the rate of return on money be changed. Mr. Chester stated that it was his belief that when the purchasing power of money decreased the compensation should increase and that this was the simplest form in which experts' opinions and lawyers' pleadings might be placed before courts and commissions as means of compensating capital.

Harold Almert[7] discussed the importance of considering that the dollar in which the property was valued was also the dollar with which the service must be paid for. He also expressed the desire that the engineer should familiarize himself with the matter of appraisal and valuation so that he should be in a position to guide the courts rather than be guided by tradition and precedent.

James E. Allison,[8] commenting on Mr. Chester's idea of adjusting the rate of return, mentioned some of the difficulties involved. He spoke of the values that a utility has, based on its desirability and based on an identical property reproduced new. He accentuated the point that getting a valuation without considering the elements of return is a very difficult procedure.

Mr. Bibbins called attention to the important part of Mr. Elmes' paper, that the dollar should not mean two things to two different people. He called attention to the difficulties thus far brought out in the discussion of both methods suggested: (1) holding value steady and varying the rate to absorb fluctuation in purchasing power, and (2) boosting property value and holding to return cost of money and rate of return on money at present in vogue. Mr. Bibbins was of the opinion that changing property would cause some embarrassment later, even though the present-day prices might continue.

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[2] Sanderson and Porter, Chicago, Ill.

[3] Consulting Engineer, Chicago, Ill. Mem.Am.Soc.M.E.

[4] Deceased. Formerly Consulting Engineer, Paine, McClellan & Campion, New York.

[5] Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. Mem.Am.Soc.M.E.

[6] Chester and Fleming, Pittsburgh, Pa. Mem.Am.Soc.M.E.

[7] Consulting Engineer, Chicago, Ill. Mem.Am.Soc.M.E.

[8] Consulting Engineer, St. Louis, Mo. Mem.Am.Soc.M.E.

E. H. Whitlock,[9] offered the solution that commodities, wages, and prices of all other articles should more or less be based on the increase in money circulation per capita.

A discussion by Bion J. Arnold[10] was read. Mr. Arnold made a strong plea for complete valuation surveys, using the various elements necessary to satisfy the purpose of the valuation, and for a consideration of the same principles in valuation for utilities that are used in industries in determining cost of service, which has been neglected in the past. He stated that in his belief much of the antagonism between corporations and the public may be ascribed to application of various intangible values without regard to the character of the project, such as contractual relations under which it is organized, efficiency of administration, etc. He decried the use of expediency in present controversies over current pricing in appraisals. In this connection he stated that current pricing is directly applicable in some instances for sales, renewals, etc., but warned against the confounding of fluctuating purchase price of money with basic capital induction and the consequent embarrassing situation of being obliged to apply this same theory, current pricing, to properties at a time when prices have slumped far below normal or cost. He pointed out that if high prices are to remain, capital investment must rise gradually, due to high prices of renewals, capital investment reaching ultimately a new higher level which, however, cannot be reached suddenly as some desire for all purposes except taxation. He emphasized the importance of amortization of that part of the capital investment which is liable to be dissipated through future developments as a factor of cost of production as great as the cost of current maintenance of the property. In closing, Mr. Arnold made a particular plea for a classification of the terms used in valuation and appraisal.

C. E. Grunsky[11] stated that in his opinion, in the matter of valuation procedure the engineering profession should establish the guideposts of progressive thought courageously, fairly and without undue dependence upon leaders' precedents, giving due weight to the decisions of the courts and commissions but only in so far as these are sound in the light of true engineering economics. As a solution of the present difficulties caused by changing values of money, Mr. Grunsky suggested the establishment of a definite commodity unit to supplement money, which will be based not on metals but on things which in civilized communities are necessary to meet the wants of man, based on definite quantities of staples such as food and fuel, iron and such of the many other things which a family requires to live in ordinary comfort. The commodity unit would be incomparably more stable than the dollar. Mr. Grunsky further suggested that the change of value of the money unit as measured by the commodity unit might be used to secure a correlated increase or decrease of public utility earnings, thus making frequent revaluation for current prices unnecessary.

In a discussion of the contributions of Messrs. Arnold and Grunsky, Mr. Allison questioned the value of principles adopted by engineers in an attempt to upset the dicta of the courts and expressed himself as being opposed to a codification of laws of appraisal and valuation by the Society. Mr. Chester spoke again on the impossibility of solving the problem of proper rate return by simultaneously raising the base and the rate.

In response to the questions raised on discussion, Mr. Elmes replied that the unquestioned right of the state to regulate commerce within its borders applied as much to a fish store as it did to a street railway and that one law or one rule of fair dealing should apply to both. Touching on the point of the relation of expansion of currency to present rise in prices, Mr. Elmes said that a study of the 1896 dollar showed that in 1919 its purchasing power had shrunk to about thirty cents, inflation of currency alone reducing the purchasing power to thirty-nine cents. He stated that in his opinion the inflation of the dollar would not go down to any serious degree in the near future and quoted Prof. Irving Fisher as saying that it looked like fifty years before we could hope for a return of prices prevalent a year ago.

A written discussion presented by B. J. Denman[12] was read. Mr. Denman confined himself entirely to the question of valuation of public utilities and called attention to the fact that the reason for the decrease in the value of securities bearing a fixed rate of return, has been the lessened value of the return on account of the decreased purchasing power of the dollar. He also showed that the common stocks of utilities decreased in value, due to the inability of utility companies to promptly pass on to their consumers increased costs of operation. Mr. Denman made a plea for fair treatment of public utilities, and in this connection emphasized the importance of "Going Concern" value, which he believed should include the following elements: Value of established business; early losses; cost of establishing business; unamortized superseded property; cost of consolidation; good will. Mr. Denman was also of the opinion that the terminology of valuation should receive careful consideration, and when formulated be given wide publicity.

In a written discussion R. H. Nexen[13] called attention to the difficulty of obtaining true cost of commodities, because of wide fluctuations in market value, and gave the results of an investigation to determine the true weighted average price paid for copper from 1904 to 1913, and also to determine whether an average base price of wire and cable could be determined for this period, using as a base the price paid for fabricated wire and market quotations of Lake ingot copper during this period. He showed a very close agreement between the average method and the actual method.

Mr. Almert spoke concerning the variation in copper prices, due to the condition of the buying market rather than to economic conditions affecting the cost of production. He questioned the inclusion in the valuation of items which had been spent in original costs of installation but which are not at present included—as, for example, a bridge built by a new railroad which is to be dedicated to a municipality.

Max Toltz[14] quoted from his experience in the building of steam roads the fact that supplementary expenses were added to the value of the road. Mr. Toltz expressed himself as being in favor of a careful study by all engineering societies of the problem of appraisal and valuation.

In answering Mr. Almert's question, Mr. Bibbins stated that he would follow the procedure of examining every possible phase of proper investment in the past, excluding nothing that pertains to a functioning property in public use, and then determine from the past records the ability of the company to amortize some of the old charges. Mr. Bibbins also stated that amortization should take place after a fair return has been paid. In closing Mr. Bibbins presented the following resolution which was adopted by the meeting:

IT IS MOVED that a Committee on Present Valuation and Appraisal be appointed by the President of the Society to review, digest and crystallize the essential features of the various papers and discussions already submitted to the Society for presentation in concise form to the next Annual Meeting for further discussion and definition; supplemented by such additional papers on fundamentals as may be submitted or requested by the Committee.

Local Session

AT the Local Session, Tuesday morning, May 25, over which E. S. Carman of Cleveland, presided, the following papers were presented: The Housing Problem, Nelson Cunliff; Industrial Housing, Leslie H. Allen; River Barges and Terminals, William S. Mitchell; Mississippi Valley River Transportation Activities, E. W. Schadek; Burning Eastern Coals Successfully on a Conveyor Feed Type Stoker, L. R. Stowe, and Tight-Fitting Threads for Bolts and Nuts, C. B. Lord. Mr. Allen's paper was published in abstract form in the June number of MECHANICAL ENGINEER-

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[9] Gen. Mgr., Am. Fire Clay & Products Co., Cleveland, Ohio. Mem.Am Soc.M.E.

[10] Consulting Engineer, Chicago, Ill.

[11] Consulting Engineer (C. E. Grunsky Co.), San Francisco, Cal.

[12] Vice-President United Light and Rwys. Co., Davenport, Ia. Mem.Am. Soc.M.E.

[13] New York City.

[14] Toltz, King & Day, Inc., St. Paul, Minn. Mem.Am.Soc.M.E.

ING; those of Messrs. Schadek and Stowe in the May number, and Mr. Lord's in the April number.

Mr. Cunliff's paper presented a problem of nation-wide importance. Because of the fact that the Priority Board declared that water works took precedence over housing the demand for dwellings throughout the country is very acute at the present time. Government statistics show that during the war there were 1,040,000 marriages, people eligible for new homes, and that there were but 27,000 houses built during that period.

The people of St. Louis have formed a home and housing organization, the purpose of which is the erection and sale of homes to the people of that city. The lives of the purchasers are insured so that in case of death the property goes to their estate which relieves the housing association and the Chamber of Commerce of being put in the position of foreclosing on widows and orphans.

The homes built are 3-, 4-, and 5-room two-story houses with hardwood floors in the lower story, and cost from $4,400 to $8,800. In all cases these houses are sold for the actual cost, which can only be figured out after the building has been completed.

Max Toltz,[1] discussing the paper, told of the housing problem in St. Paul. He pointed out that there is a shortage of 3,500 dwellings and two-thirds as many 30 to 40-flat apartment houses at the present time. Four-room frame houses cost $4,200 (the same house was built in 1917-1918 for $1,900) and brick houses $5,500 to $6,200. The home-building association that had been organized has not had much success because the people could not afford to buy houses in spite of the fact that the association gave 80 per cent of the value of the house as a first mortgage. In South St. Paul where the new Armour plant has been completed, there is a shortage of 800 houses. Inasmuch as nobody else will undertake to build these houses, the Armour Company will be obliged to build and rent them to its employees.

Regarding business houses, such as manufacturing plants and jobbing houses, of which there is a very urgent need, it is expected that nothing will be done for the next twelve months, not only because of the high prices of labor and material, but because of the fluctuation in prices. Building estimates are given with a statement that the cost sheet is "good only for today and tomorrow," and for this reason $17,000,000 worth of work is held up at the present time. As soon as material and labor can be secured at a fixed price, it is expected that a great deal of building will be done.

In closing, Mr. Cunliff pointed out that Government figures show that building costs for residences and flats have increased 215 per cent since 1914. People have been educated to pay a very considerable advance in the cost of clothes, shoes and food, but not to pay 215 per cent increase in the cost of the homes in which they live; therefore something will have to be done to bring them face to face with the fact that building costs are up and are going to remain up. The work of the St. Louis Home-Building Association is to establish people in permanent homes which they will be proud of, proud to live in, and proud to possess.

Mr. Allen's paper on Industrial Housing because of his absence was read by title only. In a written discussion Henry Wright[2] strongly advocated the building of intelligently planned flats. It was impossible to produce a well-constructed detached house of even four or five rooms so as to sell it on a basis of $50 per month. It was, however, possible to build a given amount of living space in the form of a flat at from 60 per cent to 65 per cent of what it would cost for the identical space in an individual house. A double house could be built for 10 per cent less than a single house; a cross-party-wall house, providing for four individual two-story houses, would save at least 15 per cent per unit; and houses built in rows would save 10 per cent on the end houses and 20 per cent on the middle houses. In all of these cases fuel consumption would be reduced in about the same proportion as the reduction in cost.

John R. Fordice,[3] formerly a terminal engineer of the Mississippi-Warrior Barge Line, who has made a special study of terminal conditions along the Mississippi River, in discussing Mr. Mitchell's paper, called attention to the fact that with the exception of St. Louis and New Orleans, there are no river ports providing the wharves and machinery for properly handling the cargoes which the river service is expected to carry. Among several reasons which he enumerated for the lack of terminals are: the great cost, lack of faith in the enterprise, and a lack of proper engineering and advice. The river conditions vary greatly each season; a bar may form one year where deep water existed the year before, and the course of the river may change and deep water may exist today where a town was situated last year. For these reasons the towns do not feel that they should attempt to build permanent structures.

To provide a terminal which will meet these conditions, a "terminal barge" was designed by the speaker. This barge is 250 ft. long with a 75-ft. beam and has two railway tracks, each of which holds five freight cars. It is provided with two cranes to handle heavy, unwieldy pieces of freight, eight conveyors to handle small packages, and pumps to handle liquids. This barge will anchor at the foot of a railway incline, the cars will be run on and the cargo will be transferred when necessary to river boats and barges with little difficulty. For local freight, a barge might be designed for horse-drawn vehicles and auto trucks which could be provided with removable bodies. The cargo will be unloaded either through hatches in the roof or through doors at the side, according to the stage of the river and the character of the cargo; therefore it should be easy to transfer cargo, of whatever nature, quickly and cheaply. At the present time none of these barges are in operation, but it is expected that one, now nearly completed, will be tried out in St. Louis in the near future.

Charles Whiting Baker,[4] in a written discussion, took up the subject from an economic standpoint. He pointed out that an investment of $157 per ton, which would be required for three barges and one tow boat, is a much larger investment cost than would be required for cars and a locomotive to move the same amount of freight. The crew—40 men to move 4500 tons of freight—is much larger than the train crew necessary to move such a tonnage by rail. The risk of transportation by river or canal is greater than that by ocean or lake and many times greater than that of rail transportation, and risk is an important element of cost. If private investors were asked to put their money into such an enterprise, such an estimate would have to be presented; therefore it follows that the United States Shipping Board, which is investing the taxpayers' money, should investigate this matter carefully and determine whether or not the investment will prove profitable.

In answer to a question raised by Melvin Overstrud[5] as to whether or not any investigation has been made of the feasibility of running from Stillwater, Minn., south instead of from Minneapolis and St. Paul, John N. Chester[6] asked whether or not such investigations were profitable. He pointed out the tremendous waste of money in maintaining the inland waterways of the country from which so little return is realized. He recalled the drydock at Keokuk, practically idle, and the ship locks which, with the exception of a few excursion boats, served only a small packet, which uses it twice a week at an expense of $5000 to the Government. In addition to this he mentioned the tremendous expense of the construction and upkeep of the 53 dams of the Ohio River and of the New York State Barge Canal, for all of which there was but a very small return.

John H. Bernard[7] reviewed European practice (Germany and Holland) in regard to waterways, and pointed out that because of the development in these countries the railroads have to be protected against them. One of the main reasons why there is not more water transportation in the United States is because of the lack of suitable terminals. Railroads spend a large percentage of their income on their terminals, whereas the percentage spent by barge lines is practically negligible.

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[1] M. E., Toltz, King & Day, Inc., St. Paul, Minn. Mem.Am.Soc.M.E.

[2] Advisor in Allotment and Community Planning, New York City.

[3] St. Louis, Mo.

[4] President, Baker Economic Transport Corporation, New York City. Mem.Am.Soc.M.E.

[5] Asst. to President, Twin City Forge & Foundry Co., Stillwater, Minn. Jun.Am.Soc.M.E.

[6] Chester & Fleming, Pittsburgh, Pa. Mem.Am.Soc.M.E.

[7] Transportation Engineer, New York City. Assoc-Mem.Am.Soc.M.E.

J. R. Bibbins[8] discussed the results of a comprehensive investigation made in New Orleans to determine the probable distribution of the freight movements in this country. Taking Gibraltar, Pernambuco and the Panama Canal as the basing points for export rates, it was found that for non-European ports, traffic originating south and west of a curve running from Savannah east of St. Louis and up through the northwest should move via the Gulf: for the east coast of South America all freight originating west of the line passing near Chicago should move via the Gulf; and for the west coast of South America and Pacific ports all freight west of the curve passing through Buffalo should move via the Gulf. But the fact was that the freight did not move that way; and the reason therefor was one of the biggest fundamental problems of industrial economics that existed in this country.

Theodore Brent[9] told of the activities of the Mississippi-Warrior River division during the war. He pointed out that within the last twenty years there has been no boat service on the lower Mississippi until the Government proposition was tried. During the régime of the U. S. Railroad Administration railroad river rates were secured by means of which the man living inland received the benefit of saving of what was considered, up to the present time, the proper relation between rail and rail and water rates. The fact had been demonstrated that river rates could be made that would be at least 20 per cent below rail rates, and not only save money for shipper and consumers, but pay the cost of operation as well.

Mr. Schadek accompanied the presentation of his paper by lantern slides, which showed the types of boats being built under the governmental program. He called attention to the Newton Bill now pending in Congress, which provides for the dredging of channels in the Ohio, Missouri and Mississippi Rivers, and referred to the fact that because of the importance of river transportation, the state of Illinois had appropriated $20,000,000 for the purpose of making improvements on the Chicago drainage canal.

John H. Bernhard expressed his opinion that the river terminals are not built properly. He emphasized the fact that freight must move continually and rapidly, and that removing freight by means of a vertical lift is not the best method. He pointed out the advantages of self-propelled barges in crooked rivers, and as the introducer of this type of barge expressed his regret at the present time, as he felt they could not be successful in such rivers as the Warrior, which had a number of bends of 24 ft.

Charles Whiting Baker submitted a written discussion to the effect that water transportation could in no way compete with rail transportation. Ninety-five per cent of the freight moved by rail, he wrote, is carload freight which is loaded by the shipper and unloaded by the consignee. It costs more to move a ton of freight by wagon or motor truck than to haul it 200 miles by rail. This handling is nearly always necessary with boat transportation, whereas by rail most of the carload freight is taken from and delivered to the private sidetrack of the mill, mine or warehouse. Hopper-bottom cars, which drop their load directly into the boiler-house bins, have an advantage that the floating barge cannot possibly overcome. He maintained that the burden of proof was on the waterway advocates to demonstrate, by estimates that would bear critical analysis, that freight can be moved at enough lower cost by water than by rail to induce capital to undertake the building and operating of boats. Until this was demonstrated, business would not be restored to the rivers, no matter how much more the Government spends on their channels.

R. A. Hiscano,[10] in a written discussion of the Mitchell and Schadek papers, pointed out the value of river transportation in the East. The last two months had shown conclusively that the statement made that the rail transportation systems were entirely able to take care of the country's business was far from the truth. If it had not been for the boat lines operating out of New York City to Hudson River, Long Island Sound, and New York Bay points, conditions during the past year would have been considerably worse than they were. The lack of room in New York and vicinity in which to expand rail terminal facilities made it imperative that the waterways be utilized.

Mr. Stowe illustrated his paper by means of lantern slides. R. H. Kuss [11] and R. Sanford Riley [12] paid tribute to the originality and intelligence with which the paper was worked up. Each, however, commented on the lack of data and expressed the opinion that more should have been given. Mr. Riley pointed out that hitherto experiments in mechanical stoking had perhaps neglected to give sufficient attention to the chemical side of the problem. Such a procedure as Mr. Stowe followed, he said, opens up an entirely new field and is a real contribution to the art.

Written discussions by Donald H. Hampson,[13] Wilfred Lewis,[14] and H. L. Van Keuren[15] were submitted for C. B. Lord's paper. All were impressed favorably with the idea of putting the Sellers nut on a Whitworth bolt, and welcomed this scheme as a very good solution of a perplexing problem. Mr. Lewis, however, pointed out that this scheme would develop a rivet-like joint which it would be necessary to either twist or cut apart. For the most part, nuts are put on with the idea of taking them off if necessary, therefore considerable experimental work must be done to determine the safe limits in the materials used.

Aeronautic Session

FOUR noteworthy papers were presented and discussed at the Aeronautic Session held Wednesday morning, May 26, Dean Charles Russ Richards presiding. These papers were: Physical Basis of Air-Propeller Design, F. W. Caldwell and E. N. Fales; Analytical Theory of Airplanes in Rectilinear Flight and Calculation of Maximum Cruising Radius, A. Rateau; Aeronautic Instruments—General Principles of Construction, Testing and Use, Mayo D. Hersey; and Flow of Air Through Small Brass Tubes, T. S. Taylor.

Messrs. Caldwell and Fales' contribution was exceptional, their paper, The Physical Basis of Air-Propeller Design, being given by Mr. Fales with the aid of moving pictures which showed very clearly eddies and vortices in air moving against an aerofoil in the wind tunnel. This paper appeared in abstract form in the April issue of MECHANICAL ENGINEERING.

Walter C. Durfee[1] submitted a written discussion of the paper in which he stated that if it was possible for an end of a wing to fail while the other continued to lift, as stated by the authors, numerous accidents might be looked for as one would expect an airplane to turn over sideways under such circumstances. He thought that further information of interest could be furnished by the authors concerning the need for the straighteners and just why they were located with reference to the wind tunnel as they were. It seemed probable to him that the nuclei for fog condensation in the model wing expediments were not of a chemical or electrical nature, but were certain microscopic regions of low pressure existing in the centers of axes of various small eddies.

M. C. Stuart[2] wrote calling attention to the advantages of the specific-speed method of dealing with geometrically similar air propellers in connection with their design, and referred to a paper on the subject which he had contributed to the Journal of The American Society of Naval Engineers in May, 1918.

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[8] Consulting Engineer, Chicago, Ill. Mem.Am.Soc.M.E.

[9] U. S. R.R. Administration. Mgr. of Mississippi-Warrior River Division.

[10] General Manager, Catskill Evening Line, New York City.

[11] M. E., Malcolmson Briquet Engng. Co., Chicago, Ill. Mem.Am.Soc.M.E.

[12] Pres. Sanford Riley Stoker Co., Worcester, Mass. Mem.Am.Soc.M.E.

[13] M. E., Morgan E. Wilcox Mfg. Co., Middletown, N. Y. Assoc.Mem.Am.Soc.M.E.

[14] Pres. The Tabor Mfg. Co., Philadelphia, Pa. LifeMem.Am.Soc.M.E.

[15] Gage Engineer, Wilton Tool & Mfg. Co., Boston, Mass. Assoc.Mem.Am.Soc.M.E.

[1] Consulting and Manufacturing Chemist, Winthrop C. Durfee, Boston, Mass. Mem.Am.Soc.M.E.

[2] M. E., U. S. Naval Engineering Experiment Station, Annapolis, Md. Mem.Am.Soc.M.E.

Morgan Brooks[3] said that he was impressed with the definiteness at which the discontinuity was fixed by the experiments described, and also by the superiority of the motion-picture method used by the author over the old method of point-by-point tests. There was some suggestion toward the end of the paper in regard to discontinuity having an influence on very high-speed flight. We were now reaching speeds of 600 to 700 ft. per sec. at the tip of the propeller, perhaps more, and as it had always seemed to him that discontinuity must come at the velocity of sound in air, that is, 1100 ft. per sec., in designing we might have to take account of discontinuity.

Mr. Fales, in closing, said in reply to Mr. Durfee that the energy at the tips of an airplane was a very small percentage of that in the air flow and he doubted whether the amount would be enough to upset the airplane. The use of a straightener to decrease the pulsations in the wind tunnel was the result of experiments made by Mr. C. P. Grimes and himself and was suggested originally by the flow out of a bathtub. It was found that it was possible to stop the whirl by means of such straightener as had been used.

Replying to Professor Brooks, he said that the moving pictures and photographs were vastly inferior to the actual view of the phenomenon in the wind tunnel itself. The effect of the discontinuity had already changed over the design to some extent, but he doubted whether this phenomenon would affect an airplane very greatly.

Dr. Rateau's paper on The Analytical Theory of Airplanes in Rectilinear Flight and Calculation of Maximum Cruising Radius, was presented by Prof. George O. James of Washington University, who outlined the mathematical reasoning of the author, from which the conclusion was drawn that the maximum cruising radius of an airplane today is about 4350 miles. An abstract of Dr. Rateau's paper appeared in the May issue of MECHANICAL ENGINEERING.

Walter C. Durfee, discussing the paper, wrote that since the sole object of attaining the high altitudes mentioned by the author, so far as cruising radius was concerned, was to cut down the tractive force while maintaining a perfect carburetion of fuel, it would seem that the same thing could be otherwise arranged for, as by cutting out some of the engines in case there were several; or the plane could be flown constantly at its most economical speed, allowing the surplus tractive force to be stored as potential energy of elevation, which could be used up from time to time by shutting off the engine and allowing the machine to glide. The cruising radius would then be somewhat greater as compared with the high-altitude radius, because the flight might be accomplished at a low level where the internal losses of the motor would be a small proportion of the total expenditure of energy.

J. G. Coffin[4] wrote that the author went much more into the detail of the subject than practical considerations necessitated. He had treated the question of aeroplane ranges in a paper prepared in 1918 and which had just been issued as Report No. 69 of the National Advisory Committee for Aeronautics. In this paper his aim had been to introduce the least number of complications possible and derive a practical method for giving an estimate of possible ranges. Conclusions similar to his had since been published in French, English and Italian reports. The main factors to be taken care of were evidently the propeller efficiency, the fuel consumption per horsepower-hour, and the L/D ratio for the complete plane loaded to plane empty.

E. N. Fales[5] submitted an extended written discussion in which he gave calculations, based on data taken from actual flight tests made in February at McCook Field, showing that speeds of 300 m.p.h. were possible with the Thomas-Morse M. B. 3 aeroplane tested, providing its propulsive power were maintained constant by supercharging the engine (a 300-hp. eight-cylinder Hispano-Suiza) and applying an adjustable-pitch propeller. This would mean New York to St. Louis in four hours.

Morgan Brooks said that near the close of the paper the author added one per cent to the cruising radius by planing down after all the gasoline had given out, but he had not allowed for the extra fuel it required to originally reach the altitude. Having allowed nothing for rising he thought the author was not entitled to claim the extra distance for coming down without gasoline.

In presenting his paper on Aeronautic Instruments, Mr. Hersey outlined the important work done by the Bureau of Standards in this department and supplemented it with slides showing additional types of instruments tested by the Bureau. This paper, slightly abridged, was published in the May issue of MECHANICAL ENGINEERING.

Alexander McAdie,[6] discussing the paper, wrote that the typical altimeter as described by the author would show an error of 8 per cent at 25,000 ft. elevation and the outstanding need was for a temperature correction. It was a fact that Doctor Jeffries, who crossed from England to France through the air in 1785, could tell his maximum elevation (6600 ft.) with his mercurial barometer with much greater accuracy than a present-day flier with an altimeter.

The atmosphere had been quite well explored and pressure, temperature and humidity conditions determined for heights far beyond airplane or airship limits. The lowest temperature in the air thus far obtained was — 130 deg. fahr. at 17,000 m. elevation over the equator. A temperature scale successfully used for several years at the Blue Hill Observatory had its zero at absolute zero and 1000 for the freezing point. This eliminated minus signs and degree symbols and was known as the 4 K system.

It seems to be impracticable for an aviator to determine the true velocity while both machine and air were in motion, but by sending him from a certain point a combined wireless and sound signal, a close approximation of his distance from the source could be made. The interval between the arrival of the two signals made simultaneous would give the time of travel of the sound or aerial wave, and the proper correction for temperature and density, the distance.

Elmer A. Sperry,[7] in a written discussion, called attention to the unreliability of the magnetic compass in fog, cloud and night flights. It was highly reliable in straight flight, however, but this was extremely difficult when no landmark could be seen. The gyroscopic turn indicator he had developed had been made to indicate clearly a turn about a radius as great as five miles, distinguishing clearly between this and straight flight; and by thus safeguarding the magnetic compass very excellent navigation had been secured. The great advantage of dealing with true geometric meridians and the high degree of accuracy attained by the gyroscopic compass made it very desirable for large aircraft.

Albert F. Hegenberger[8] wrote concerning the work of the Engineering Division, Air Service, in developing aeronautical instruments, especially those for military work. A new sensitive barograph which had been functioning successfully for several months would record a change in altitude of about 30 ft., and a mechanical rate-of-climb meter now being tested out used a sylphon for the sensitive diaphragm element and had worked very well. Aeronautical instruments, however, were still very far from satisfactory. Gyroscopic compasses thus far tested had been affected so greatly by bumps and similar accelerations as to be worthless. Turn indicators of the gyrostatic type should be improved to prevent oscillations of the hand, which were very confusing. The static-head type was free from this vibration, but was affected by side slips and skids. A great many instrument problems would be solved if some means could be developed for indicating the true vertical and horizontal. Increasing reliance was being placed on instruments as they continued to improve and it was not at all improbable in the near future that large aeroplanes and planes with enclosed cockpits would be flown entirely by instruments.

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[3] Professor of Electrical Engineering, University of Illinois, Urbana, Ill. Life Mem.Am.Soc.M.E.

[4] Director of Research, Curtiss Aeroplane & Motor Corpn., Garden City, L. I., N. Y.

[5] Air Service. Engineering Department, McCook Field, Dayton, Ohio.

[6] Director, Blue Hill Observatory (Harvard University), Readville, Mass.

[7] President and Engineer, The Sperry Gyroscope Co., Brooklyn, N. Y. Life Mem.Am.Soc.M.E.

[8] Second Lieut., A. S. A., Air Service Representative, Dayton, Ohio.

J. A. Hoogewerff[9] wrote that Mr. Hersey did not sufficiently stress the point that it was most necessary for the air pilot to have a thorough knowledge of the instruments available for his use and respect for them based on that knowledge. He should be sufficiently informed to make due allowances for instrumental errors and inaccuracies, but he should also realize that good instruments are far more accurate than human judgment and that to depend on judgment alone might be fatal.

Thomas D. Cope,[10] in a written communication, stated that an experimental gasoline depth gage tried out at Langley Field had given excellent service and reliable indications. Its new features consisted of a ball-and-socket endless chain running over pulleys and actuated by a float. The motion of the upper pulley was communicated through a ground joint to a rack and pinion and thus by a wire to a dial and pointer on the instrument board.

In closing Mr. Hersey said, apropos of Admiral Hoogewerff's remarks on the need for training pilots, that it might be of interest to those present to know that the Aeronautic Instrument Section at the Bureau of Standards had conducted two schools during the war in which scientific courses were given to naval officers to fit them to take charge of instrument work in the Navy. This was done at the request of the Chief of the Bureau of Operation. He felt that the discussions that had been presented were all useful contributions to the subject of the paper.

Mr. T. S. Taylor's paper on the Flow of Air through Small Brass Tubes appeared in June MECHANICAL ENGINEERING. Mr. Taylor was unable to be present and his paper was presented by title.

H. Wade Hibbard[11] said that while Mr. Taylor's tests showed that for a tube 1½ in. in diameter it required a length of flow of 50 diameters to reach a stable condition, he would state that in large conduits the case was different. He had found that in transporting sawdust and shavings by air blast through a 3-ft. metal conduit 800 ft. long, if a piece of metal accidentally fell into the material being transported, it would dent the conduit its entire length, and that the dents would be apparently as numerous toward the end as at the beginning.

Mayo D. Hersey asked if the author had compared his experimental results with the well-known formula of Dr. Lees. This was recognized in England as covering the law of the flow of fluids through any form of pipe, and it would be of value to have the comparison made.

Castings Session

THE Castings Session convened on Wednesday morning, May 26, with F. O. Wells, Manager of the Society, presiding. The session was organized by the former Sub-Committee on Foundry Practice as a symposium on the various types of castings and the papers, including information as to what may be obtained from commercial foundries, are of great value to designing engineers. The symposium consisted of the following papers: Malleable Castings, Enrique Touceda; Die Castings, Charles Pack; Aluminum Castings, Zay Jeffries; Steel Castings, John H. Hall; Gray-Iron Castings, Richard Moldenke, and Brass and Bronze Castings, C. H. Bierbaum. Dr. Moldenke was present as the representative of the Foundry Committee and guided the discussion which culminated in an expression of desire to hold further meetings to consider the foundry problems of the engineer. Mr. Pack was also requested to present a treatise on die castings for the Annual Meeting.

The castings papers, together with an account of the discussion which they elicited, will appear in abstract form in a future number of MECHANICAL ENGINEERING.

Scientific Session

THE Scientific Session on Thursday morning was a joint session with the American Society of Refrigerating Engineers and the American Society of Heating and Ventilating Engineers, both of which organizations were meeting in St. Louis for their spring conventions. Mr. Matthews, president of the American Society of Heating and Ventilating Engineers, presided at the meeting and five papers were presented, three being contributed by The American Society of Mechanical Engineers, and one each by the Refrigerating, and Heating and Ventilating Engineers. These papers and authors were as follows: An Improved Form of Weir for Gaging in Open Channels, by Clemens Herschel; Simplification of Venturi-Meter Calculations, by Glenn B. Warren; The Dissipation of Heat by Various Surfaces, by T. S. Taylor; The Thermal Conductivity of Heat Insulators, by M. S. Van Dusen (contributed by Am. Soc. R. E.); and Ship Ventilation, by F. R. Still (contributed by A. S. H. & V. E.).

Of the papers presented by The American Society of Mechanical Engineers, that by Mr. Herschel appeared as the leading article in the February issue of MECHANICAL ENGINEERING (p. 83), while the papers by Messrs. Warren and Taylor will be found in abstract form in the April issue, on pages 220 and 230, respectively.

Mr. Herschel's paper, presented by F. R. Low,[1] outlined the results of a series of investigations on weirs which mark a distinct step forward in the measurement of water by that means. The investigations were undertaken at the instigation of the Power Test Code Committee of The American Society of Mechanical Engineers and the necessary funds were supplied by Engineering Foundation. The new weir which is described in the paper bears no resemblance to the sharp-edged weir now in general use, for its crest is made in the form of an arc of a circle and is hollow for observing the pressure at that point. Mr. Herschel's tests showed that for discharge of from 0 to 9.55 cu. ft. per sec. per ft. of weir length, the limits covered by the experiments, the quantity of water flowing, Q, was directly proportional to the difference, d, in two pressures, one measured just upstream of the weir, and the other measured at the crest, the formula being $Q = 5.50\ d$.

In the discussion which followed A. M. Greene, Jr.,[2] stated that he was unable, by means of the formula given, to compute the results which were tabulated by the author. He therefore asked that Mr. Herschel furnish at least one set of the complete data so that he might be able to follow through the computations and accordingly check the values given. Professor Greene also asked why Mr. Herschel selected the position for the hook gage as stated in his paper when he claimed that hydraulic engineers do not know where to put the hook gage in the standard form of sharp-crested weir.

Dean R. L. Sackett,[3] in discussing the use of weirs now commonly employed, stated that the weir itself ought not to be condemned, but rather the methods employed in its use, for in the past there has been no agreement either upon a standard type or upon the position at which to measure the head. The new weir is not the only one in which sharpness varies as the head, as recent laboratory tests indicate that a sharp-crested weir of a standard curved type in vertical position does have a constant coefficient within the range of experiments made. It might therefore appear, Dean Sackett said, that the new weir is better for large volumes of water than the old type, but in the measurement of water used for cooling purposes or return water in power plants, a sharp-crested weir of standard type with a coefficient, one where the discharge would vary in its head, would be of great advantage.

C. G. Richardson[4] said that to his personal knowledge Mr. Herschel would be greatly pleased if the technical schools and colleges would study this problem and carry on investigations along the line he had suggested. He further stated that F. M. Connet,[5] in discussing with him the features of the new weir, had expressed the opinion that it seemed to be a special form of venturi tube and it should, therefore, be expected that the quantity flowing would vary as the one-half power of H, where H represents the difference in head between the inlet and throat of that special venturi tube. It seems possible, however, that the departure from the formula so that Q varies directly as the head may be due to the departure of the stream line from the true venturi principle as it passes over the contraction or, one might say, the throat of the tube.

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[9] Rear-Admiral. U. S. N.; Supt. U. S. Naval Observatory, Washington, D. C.

[10] Assistant Professor of Physics, University of Pennsylvania, Phila.

[11] Professor of Mechanical Engineering, University of Missouri, Columbia, Mo. Mem.Am.Soc.M.E.

[1] Editor, *Power*, New York. Vice-President Am.Soc.M.E.

[2] Professor of Mechanical Engineering, Rensselaer Poly Inst., Troy, N. Y. Mem.Am.Soc.M.E.

[3] Dean of Engineering, Penn. State College, State College, Pa. Mem.Am.Soc.M.E.

[4] Chief Mechanical Engineer, Taft-Pierce Co., Woonsocket, R. I. Mem. Am.Soc.M.E.

The second paper of the session, Simplification of Venturi-Meter Calculations, by G. B. Warren, was presented by title only. It describes a method devised by the author which reduces the calculation of venturi-meter measurements to a simple slide-rule computation requiring but a few settings. Written discussions of Mr. Warren's paper were presented by Thomas G. Estep,[6] M. C. Stuart,[7] and C. G. Richardson.[8] Additional discussion will also be found in the Correspondence Section of this and the May issues of MECHANICAL ENGINEERING.

Mr. Estep in his discussion called attention to the fact that the equations developed by Mr. Warren are simple derivations of fundamental equations for the frictionless adiabatic flow of elastic fluids and credit is therefore due to older investigators than those mentioned by Mr. Warren. He also presented a formula which he had developed, with the suggestion that if it is desired to simplify the calculation that an impact tube be used instead of the upstream static opening, retaining, however, the static opening at the throat. The differential pressure then represents the total velocity at the throat instead of simply the change in velocity as when the two static openings are used. He also stated that in his opinion Mr. Warren's calibration shows that H. B. Reynolds'[9] empirical equation for a thin-plate orifice is a good one, but it does not prove the accuracy of the venturi meter.

M. C. Stuart stated that several years ago he had developed a method of simplified calculations almost identical with that presented in the paper, and in his discussion gave details of his method.

M. S. Van Dusen, of the Bureau of Standards, next presented his paper on the Thermal Conductivity of Heat Insulators, which dealt with the development of the methods for measuring the insulating properties of materials. Mr. Nichols, in discussing Mr. Van Dusen's paper, called attention to the necessity in heat-measurement work of settling upon a definite and very closely regulated method for absolute conductivity measure. Messrs. Cramer, McGeorge, F. R. Still, Voorhees, and L. R. Whitney also discussed the paper, commenting chiefly upon the excellent scientific work being done at the Bureau of Standards whose research work is of value to the entire country and not limited in application to any particular class of industry. This sentiment was the result of a suggestion by one of the discussers that the large industrial corporations might very profitably finance scientific investigations being carried out under the direction of the Bureau of Standards.

The paper by T. S. Taylor on the Dissipation of Heat by Various Surfaces, dealt for the most part with the value of sheet asbestos as a covering for hot-air furnace pipes. In addition to the oral discussion which follows, there were two written discussions, one by A. C. Willard and V. S. Day, of the University of Illinois, and one by L. R. Ingersoll, of the University of Wisconsin.

The discussion by Messrs. Willard and Day dealt chiefly with the first part of Mr. Taylor's paper. They pointed out that in general Mr. Taylor's results confirmed the work of a similar nature already completed at the University of Illinois and reported in Bulletin No. 117 of the Engineering Experiment Station as the Emissivity of Heat from Various Surfaces, by V. S. Day. In fact, when the results of the two investigators are compared on the basis of the excess of surface temperatures of the cylinders above the surrounding room temperatures, a satisfactory agreement results. Messrs. Willard and Day also pointed out that the only definite basis for estimating the amount of heat dissipated by thin metal surfaces which separate air or gas at high temperatures from air or gas at low temperatures, is the difference in temperature between the surface itself and the temperature of the cooler surrounding air. The values given by Mr. Taylor are used as a basis for a calculation, as the result of which they conclude that Mr. Taylor's values of the coefficient of emissivity when surface temperatures are used as a basis are only 5 to 6 per cent lower than Mr. Day's values for bright tin cylinders.

L. R. Ingersoll, in commenting upon the paper, stated that the results are by no means striking to one familiar with the main laws of heat transference. The effect would be exaggerated if the pipe were of very small diameter, for in this case the addition of insulation would add appreciably to the radiating surface. From a practical standpoint, however, furnace pipes are so generally dirty and dusty that to leave off the customary asbestos-paper covering in the expectation of saving heat would be a practice of doubtful wisdom.

L. B. McMillan[10] called attention to the fact that the author's conclusion that a thin layer of asbestos paper applied loosely to a bright surface increased the loss of heat from the surface, is undoubtedly correct and in accord with former tests of the same general nature. The increase in heat loss, he said, is entirely due to the change in character of the exposed surface. The addition of a thin layer of asbestos adds some resistance, but not enough to offset the decrease in surface resistance. In the case of furnace pipes the loss from the bright surface is so great that it would be wasteful to leave them bare. The important factor, therefore, is what one thickness of insulating material will save as compared with another. He also called attention to the superior insulating qualities of cellular construction and stated that actual tests at the University of Illinois on surfaces covered with three layers of air-cell asbestos showed a saving of twice that obtained by the same material by the author's calculations.

Mr. McMillan also stated that experiments have established the fact that radiation from a galvanized surface increases very materially as the surface becomes tarnished. Tests reported in *Engineering,* October 19, 1917, showed that galvanized iron exposed to the weather for one year offers practically no more resistance to radiation than does black iron.

E. R. Hedrick[11] called attention to the fact that the laws that were presented were for entirely different circumstances than the laws for the dissipation of heat when gas or other material is passed through the pipe, for in that case a very important consideration, especially as there is a considerable drop in temperature, is the passage of material down the pipe. However, since the experiments were conducted in a box of uniform size, agreement between the laws that are represented and the laws for the transmission of heat which apply for a material being passed through a pipe, is not expected. Mr. Hedrick also commented on the formula and curves given by the author, and stated that he had not succeeded in doing more than check the formula presented and in his opinion it did not hold. He also stated that the observations were limited because they had been carried on for a difference of only 10 deg., which in his opinion constituted an insufficient basis for argument for ordinary heat transmission.

J. D. Hoffman,[12] in commenting upon the value of Mr. Taylor's paper, stated that he considered it of especial value because of the fact that it confirmed the work that had been done at the University of Illinois and the results obtained were also in close accord with the work done by Mr. Soll, of the American Radiator Company in his investigation on blast heating.

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[5] Chief Engineer, Builders Iron Foundry, Providence, R. I. Mem.Am.Soc.M.E.

[6] Assistant Professor Mechanical Engineer, Carnegie Inst Tech. Mem.Am.Soc.M.E.

[7] Mechanical Engineer, U. S. Naval Engineering Experiment Station, Annapolis, Md. Mem.Am.Soc.M.E.

[8] Sales Engineer, Builders Iron Foundry, Providence, R. I. Mem.Am.Soc.M.E.

[9] Trans. Am. Soc. M. E., vol. 38 (1916), p. 799.

[10] Construction Engineer, H. W. Johns-Manville Co., New York, N. Y. Assoc-Mem.Am.Soc.M.E.

[11] Professor of Mathematics, University of Missouri, Columbia, Mo. Mem.Am.Soc.M.E.

[12] Professor, Director of Practical Mechanics, Purdue Univ., Lafayette, Ind. Mem.Am.Soc.M.E.

The final paper of the session, on Ship Ventilation, was presented by F. R. Still[13] of the American Society of Heating and Ventilating Engineers. This paper, which appeared in the April issue of the *Journal of the American Society of Heating and Ventilating Engineers,* page 363, takes up the subject of ventilating passenger ships, refrigerating ships, cattle ships, general freighters, and lake and river steamers. There was no discussion.

Power Session

THE interest among mechanical engineers in the subject of power was evidenced by the announcement at the Power Session of Friday morning, by F. R. Low, that over 700 members had expressed a desire for a Power Section and that (as announced elsewhere) at a meeting previously held steps had been taken for the formation of such a Section. Prof. Robert H. Fernald presided at the Power Session and four papers were discussed as follows:

The first paper, by Otis L. McIntyre, New York, dealt with experiments on pulverized coal which led to the installation of apparatus for its use in the metallurgical furnaces of the Cerro de Pasco Copper Corporation at La Fundicion, Peru. These were unique in that they were conducted at an altitude of 14,000 ft., a condition under which there have been practically no data available. It should be said, also, that the paper itself is unique in that the difficulties encountered in the development of the apparatus are plainly stated. The pros and cons of pulverized fuel are all of interest to the engineer, but it has usually been easier to get at the pros than the cons in papers prepared on this subject.

W. N. Best,[1] the only one to discuss this paper, styled it as "excellent." His only criticisms were on the number of burners used and lack of combustion space provided. With pulverized coal as few burners as possible should be used—one burner will give better results than two or four because the flame and temperature can be more easily controlled by the operator. A combustion chamber is not only required for good combustion of the fuel, but will prevent the piling up of the unconsumed fuel before reaching the bath of molten metal.

The second paper, on Efficiency of Natural Gas Used in Domestic Service, by Robert F. Earhart, Columbus, Ohio, touched a vital point in the fuel situation in this country. The supply of natural gas is no longer sufficient for both industrial and domestic purposes; and under the present wasteful methods it will not long be sufficient even for the latter use. Anything contributing to greater economy in the consumption of gas in the thousands of homes in the natural-gas regions, therefore, is of the greatest importance. The paper reports the results of a series of efficiency tests on natural gas made in the physics laboratory of Ohio State University. The conclusions relate mainly to the location of the burner with respect to the utensil on the stove and show that with proper adjustment an efficiency in excess of 45 per cent can be secured.

G. I. Vincent,[2] in a letter on the subject, wrote that whereas it was known in a general way that the position of the burner under the vessel in domestic appliances materially affected the efficiency, investigators had not sufficiently emphasized the fact that the efficiency of gas-burning appliances and cooking vessels of the present design is very low. Only a small part of the heat goes to cook the food immersed in the water. The saving from properly designed and located burners would hardly be a drop in the bucket compared with what might be accomplished by revolutionary changes in the design of household utensils and gas-burning appliances. While the latter might be possible, however, the former presents an almost impossible task. Another saving would be accomplished if the gas supply could be cut off as soon as a cooking process was completed or a vessel removed from the stove.

A general discussion followed, chiefly upon the relation between the gas pressure and the mixture of air and gas, and the possible use of automatic devices for varying the air supply with the pressure, or with the height of flame, such as used in large gas annealing furnaces. Suggestions to this end were made by H. B. Dirks, H. R. Godeke, and H. S. Dickerson.

John Borge[3] said there are a number of burners on the market in which the air shutter is geared to the gas part so that opening part way would admit a certain amount of air and opening further would admit correspondingly more air. Investigations show, however, that there is not much justification in such an elaborate combined valve.

There was also discussion by Victor J. Azbe and others on efficiency, or inefficiency, in larger installations than required in domestic kitchens, such as in bakeries, etc. One instance cited was of a large plant using gas to the value of $200 a day, but at an efficiency of 20 per cent when it should have been 50 per cent with suitable equipment and adjustments.

The next paper, on Locomotive Feedwater Heating, by Thomas C. McBride, described a recently-developed system of feedwater heating for locomotives which makes use of the open type of heater in which the exhaust steam comes in direct contact with the cold feedwater. Mr. McBride said that the practice of feedwater heating for locomotives is followed abroad far more extensively than in this country. In 1918 a single road in France had 61 heaters in service and he had been informed that all the German locomotives turned over to the French under the terms of the armistice had feedwater heaters.

F. N. Speller[4] said that information upon the amount of gas separation in the type of heater described by the author would be of interest as an indication of whether there would be less corrosion in the boiler through the use of an open heater. An open heated of adequate size has a marked effect in retarding corrosion in stationary boilers. A serious objection to closed heaters is the rapid deterioration of the heater itself through the action of corrosive gases in solution. He further referred to heater tests on a western road which showed rapid deterioration.

George M. Basford[5] sent a comment to the effect that while the paper covers certain phases of the subject which have not been well understood and gives new data of value, it is unfortunate that the author confined his treatment to the open type of heater. He had presented his subject in a somewhat less favorable light, in some particulars, than he might have done if he had included results obtained with the closed type of heaters on a number of railroads in this country and abroad.

Grafton Greenough[6] wrote that there is every evidence that the necessity is upon us for the reappearance of the locomotive feedwater heater which, as stated by the author, has lain dormant for over three-quarters of a century. This necessity is twofold: First, the sizes of our most powerful locomotives are seriously restricted by physical conditions and any device which will enable us to obtain greater horsepower without increasing the size of the locomotive boiler should receive attention; and second, there is urgent need for conserving labor, money and the transportation facilities required in producing and delivering coal. The locomotive feedwater heater is a practical agency whereby the size of the locomotive boiler may be reduced and a saving in fuel effected. He predicted that before long it would be regarded as an established device in common with means for superheating and compounding, needful to bring about greater efficiency and economy in the locomotive engine.

The final paper of the session, on the Separation of Dissolved Gases from Water, by J. R. McDermet, awakened a great deal of interest and elicited considerable discussion. Valuable data were given, based on extended experiments leading to the practical development of the process originated by W. S. Elliott of Pittsburgh. Fundamentally it consists of the rapid injection of heated water into a region of vacuo, and an explosive boiling of it at the expense of the heat of the liquid, with a simultaneous recovery of the heat liberated by a heat interchanger or condenser cooled by the incoming water, preliminary to its heating.

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[13] Vice-President, American Blower Co., Detroit, Mich. Mem.Am.Soc. M.E.

[1] Pres., W. N. Best, Inc., New York. Mem. Am. Soc. M. E.

[2] Engineer, Syracuse Lighting Co., Syracuse, N. Y. Mem. Am. Soc. M. E.

[3] Pres. Borge Incinerator Corp., New York City. Assoc-Mem.AmSoc.M.E.

[4] Metallurgical Engineer, National Tube Co., Pittsburgh, Pa.

[5] Pres. Loco. Feed Water Heater Co., New York. Mem. Am. Soc. M. E.

[6] Vice-Pres. in Charge, Baldwin Loco. Wks., Philadelphia.

F. N. Speller, in a written discussion, said that the oxygen content of natural water varies from 5 to 10 cc. per liter, according to seasonal temperature. It is desirable to remove dissolved gases as far as possible in an open heater. Quoting the performance of three open heaters in different plants, he said that one heater operating at a temperature of 170 deg. fahr. left in the water an average of 2.55 cc. per liter; another at 204 deg. an average of 0.75 cc. per liter; and the third at 209 deg., 0.70 cc. per liter.

Experience indicates, however, that to prevent corrosion the feedwater used with steel economizers should carry less than 0.20 cc. per liter. Experimental work done by his company and by Dr. W. H. Walker of the Mass. Inst. of Technology indicates that open heaters as usually operated will not reduce the oxygen low enough to stop corrosion. The residual oxygen, after passing through a properly vented open heater, may be reduced below the danger point by further mechanical deaeration, such as passing the water over baffles at about the boiling point in a separate chamber at lower pressure, or by injecting the superheated water into a low-pressure chamber with a condenser in series, as described by Mr. McDermet; or the residual oxygen passing through the heater may be quickly and completely removed by chemical treatment, or a combination of both systems as most convenient. His company, he said, had used the latter principle for five years. It is based on passing the heated water under pressure through a large mass of expanded steel scrap, which he termed "deactivating" the water in distinction to mechanical deaeration.

C. M. Garland[7] wrote that with coal at $6 a ton there are few plants that cannot afford to install the most efficient boiler-room equipment obtainable. This means the installation of economizers. The economizer, however, has not yet reached the stage of development which might be expected, due mainly to the corrosive action of dissolved gases in water. This action has made it necessary to use cast-iron tubes, which must be of large diameter and for high pressures of heavy weight, making the economizer bulky, clumsy and to a large extent impractical.

If the author's investigations and apparatus lead ultimately to the elimination of corrosion in economizer tubes, he will have eliminated one of the most difficult problems in economizer design. Steel-tube economizers can be designed to occupy about one-eighth the space allotted to economizer equipment and will greatly reduce the cost of such installations.

Geo. H. Gibson,[8] in a written communication, said that while the author had credited the method described to W. S. Elliott, it had been pointed out by Wm. H. Walker, in a paper before the Iron and Steel Institute in 1909, that pitting might be entirely avoided by removing air from the feedwater before its introduction into the boiler and that this might best be done by the employment of an open feedwater heater connected to the dry-vacuum pump of a condenser. Also he referred to a similar proposal for the elimination of corrosion in the famous 350-mile Coolgardie pipe line for the Goldfields Water Supply, of Perth, Western Australia, in 1909.

Mr. Gibson contended that effective separation of air can be effected without the complication of vacuum appliances and quoted results obtained by heating water in an open feedwater heater. Under atmospheric pressure the oxygen content has been reduced slightly below 0.2 cc. per liter with the water at the outlet at 210 deg. fahr. It was found essential that the heater outlet temperature be near 212 deg., the oxygen content increasing rapidly at lower temperatures. The maintenance of high temperature in a heater operating under atmospheric pressure requires careful attention to water distribution and to venting.

R. N. Ehrhart,[9] in reply to Mr. Gibson, with regard to the utility of the open heater in preventing corrosion, said that both the author and Mr. Speller had realized the necessity of taking out the oxygen, which the open heater will not do. Some companies have attempted to check corrosion by raising the feed temperatures, say, from 130 to 140 deg. to 210 deg., but the consensus of opinion is that this will not produce the results and that air-extraction apparatus is absolutely essential.

E. H. Tenney[10] pleaded guilty to being one of those who had raised feedwater temperatures and said that there had since been no indication of corrosive action in the economizer. In the Mississippi Valley, where his company's plants are located, the water is highly impregnated with dissolved organic matter, which gives another important problem to be dealt with in addition to that of dissolved gases. This is a troublesome subject which he believed could well be taken up for consideration by the Society.

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[7] Manager Power Dept., Allen & Garcia Co., Chicago, Ill. Mem. Am. Soc. M. E.

[8] Consulting Engineer, Geo. H. Gibson Co., New York. Mem. Am. Soc. M. E.

[9] Elliott Co., Jeannette, Pa. Mem. Am. Soc. M. E.

[10] Chief Engineer of Power Plants, Union Electric Light & Power Co., St. Louis, Mo. Mem. Am. Soc. M. E.

Members Enjoy Oil Field Visit

THE Mid-Continent Section of the A. S. M. E. and the Oklahoma Section of the American Chemical Society held a joint meeting at Tulsa on May 28 and 29, the occasion being noteworthy as the first joint meeting of a chemical and an engineering society.

Following the St. Louis meeting, about 50 members of the A. S. M. E. left for Tulsa, arriving there Friday morning. They were conducted to the Hotel Tulsa by the Local Section to join them at breakfast at the hotel. Mayor Evans delivered the "keys of the city with all the ceremonies," and promised the visitors that they would either leave the city millionaires or "broke." President Miller responded in his usual gracious manner.

The first part of the morning was spent in riding around the beautiful, well-laid-out city of attractive homes and imposing office buildings. At 11 o'clock the local members with their guests gathered at the Cosden Refinery, where, under the guidance of F. E. Holsten, manufacturing superintendent, and W. H. Pape, mechanical superintendent, the intricacies of the $20,000,000 refinery were explained. The ingenious devices installed to promote the safety of operation for the employees and the various processes of distillation and filtration were gone over thoroughly The plant has a capacity of about 25,000 barrels per day.

Luncheon was served at the refinery of the Texas Company. Mr. W. K. Holmes, superintendent of the refinery, conducted the party through the spotlessly clean plant which attracted very many favorable comments.

A short business session held in the City Hall auditorium was followed by a professional session, at which the following papers were presented:

The Preparation of Motor Gasoline from Heavier Hydrocarbons, Prof. Fred W. Padgett
Modern Water Purification, W. R. Holway
Refining of Crude Mineral Oils and the Action of Absorptive Clays on Same, F. C. Thiele
Flow of Fluids through Pipe Lines and the Effect of Pipe-Line Fittings, D. E. Foster
Some Investigations in Briquetting of Oklahoma Bituminous Coal, Prof. James C. Davis
Mid-Continent Gasoline, Dr. Chas. K. Francis
Coal vs. Oil Cost Performance Chart, L. C. Lichty

Professor Padgett's paper is presented on another page of this issue, and the other papers will receive consideration in later issues of Mechanical Engineering.

SECTION OF OIL FIELDS SOUTHWEST OF TULSA

A banquet was given at the Hotel Tulsa in the evening, Louis Bendit, the dean of engineers in Tulsa, serving as toastmaster. Frank Greer gave a rapid-fire sketch of the remarkable development and marvelous resources of Tulsa, the Magic City, and Oklahoma, the Billion-dollar State. President Miller spoke of the development of coöperation among engineers and of the problems of relation between employer and employee, emphasizing the fact that there must be correct relations for proper production. Dean P. F. Walker, of the University of Kansas, presented the report of the Mid-Continent Section Research Committee which will be abstracted in the August issue of MECHANICAL ENGINEERING. Secretary Rice spoke on the subject of the engineer and his citizenship responsibility and laid out the broad lines on which the activities of the engineer must be organized.

On the following day the party was organized early for a 60-mile automobile trip to the casing-head gasoline plant of the Gypsy Oil Company, crude-oil pumping stations, and the Glenpool oil fields. Mr. H. P. Porter, chairman of the Mid-Continent Section and superintendent of the Gypsy casing-head plant, revealed the mystery of making gasoline in his plant. A most interesting instance of the complete utilization of heat energy was afforded at this plant. After the high-pressure gas has passed the usual condenser and had the normal amount of liquid removed, it is led to a cross-compound engine where it serves as an expansive vapor in the same manner as steam is commonly employed. In this expansion the gas is reduced to a very low temperature, this action being made cumulative in a counterflow system of pipes whereby it is made to refrigerate itself on the way to the engine and in this way extracts from itself an amount of high-gravity gasoline which could not have been recovered in the ordinary high-pressure condenser using water as the cooling system.

A specially arranged feature of the day was the shooting of an oil well. The party watching at a respectful distance saw the 80 quarts of nitroglycerine poured carefully into the tube and lowered 2200 ft. to the bottom of the well. They waited while the casing was being withdrawn but only a few venturesome spirits stayed on, in spite of a foreboding storm and the approaching train time, to see the final shot. Those who did stay witnessed the remarkable spectacle of a fountain of oil mounting 60 ft. above the top of the derrick—but missed their train.

The entire meeting and program of excursions was a brilliant success and every detail of arrangement was worked out very carefully by Messrs. H. P. Porter, J. H. McEwen, D. E. Foster and Earle A. Clark, the officers of the Mid-Continent Section, to all of whom the thanks of the Society are due.

OIL REFINERIES AND STORAGE TANKS OF WEST TULSA. ARKANSAS RIVER IN DISTANCE

Motor Gasoline from Heavier Hydrocarbons

Particulars Regarding Its Preparation by Various Cracking Processes, Together with a Discussion of the Theory of Cracking and Notes on the Present Status of the Industry

By FRED W. PADGETT,[1] NORMAN, OKLAHOMA

The following paper is one of the group prepared by the Mid-Continent Section of the A.S.M.E. for the Tulsa, Okla., meeting held immediately after the Spring Meeting of the Society at St. Louis, and which was attended by a good-sized delegation of those who were present at the latter meeting. It is mainly concerned with those methods known as "cracking" processes which, when applied to the heavier hydrocarbons present in petroleum, produce mixtures within the range of motor fuel. It has as its objects the discussion of the theory of cracking, the description of standard processes, and the consideration of the present status of the industry. It will be found a convenient and valuable summary of the various processes, particularly useful for reference purposes.

THE growing importance of the internal-combustion engine during the past decade has brought with it the attendant problem of fuel supply. While the production of motor fuel in the past has been ample, the data indicate that in the near future we shall be faced with the problem of augmenting the supply, or see a depressing effect upon the automobile industry on account of shortage. The Bureau of Mines in a recent report on refining statistics shows that the gasoline production in 1919 increased 10 per cent over 1918. On the other hand, the number of automobiles registered increased 22 per cent during the same period and the increase of 1920 will be of like order. The question therefore presents itself as to how it will be possible to meet the future demand for motor fuel even though gasoline stocks were increased during the past year. The problem is not now a serious one, but may become so in a very few years.

There are several sources from which additional supplies of motor fuel may be expected. Benzol and toluol from by-product coke-oven plants may be blended with gasoline to give a very satisfactory product, while industrial alcohol is a product to fall back on, if necessary. Crude oil may also be derived from such kerogenous substances as oil shale and there are enormous deposits of the raw starting material in various parts of the country, expecially in Colorado, Wyoming, and Utah, from which the crude oil may be extracted by low-temperature carbonization or a combination of this with ultimate high-temperature effect in the presence of steam to recover the by-product ammonia.

Petroleum consists essentially of a mixture of hydrocarbons which are in the main totally miscible with one another. Organic nitrogen and sulphur compounds are also present in varying amounts and occasionally oxygen compounds, as well as water and inorganic material in disperse form. When this complex of naturally occurring hydrocarbons is treated by dry distillation at atmospheric pressure, the hydrocarbons of lowest boiling point are vaporized first and come into the condenser followed by those of higher boiling point as the temperature rises. Varying degrees of fractionation will obtain depending upon the design of still and method of operation. From the point where gases first appear at the condenser outlet until the temperature in the still reaches approximately 625 deg. fahr., the products secured are in the main natural—that is, they exist in the crude oil as such. Above this temperature, however, especially if the distillation is carried out slowly, what is known as "cracking" takes place and a distillate is secured, which upon redistillation will yield more gasoline and kerosene, their quality, however, in most cases, not being comparable with that of the natural products.

If instead of carrying out the distillation above the 625 point at atmospheric pressure in an ordinary still, one of special design is substituted, and if the operation is conducted at a pressure varying from 50 lb. to 150 lb., profound decomposition or cracking occurs and a yield of gasoline of 15 per cent or more may be obtained, based on the original charge of residue, upon fractionating the pressure distillate secured. The residue remaining, and the pressure distillate which has thus been freed from gasoline, may again be subjected to the process and a further yield of gasoline secured, this being less than in the first case and decreasing upon subsequent treatments.

This process of cracking is a special application of the well-known phenomenon which occurs when organic compounds are heated to a high temperature, decomposition taking place and the molecule being broken down into compounds of lower molecular weight, even with the formation of the elements carbon and hydrogen.

Again, if a sample of the same residual oil be placed in a vertical still having a fractionating column or "tower" interposed between the still and the condenser, and the distillation is carried out at atmospheric pressure, with stirring, in the presence of anhydrous aluminum chloride, the latter acts as a catalyst to cause the decomposition of the oil into gasoline, giving a yield of 15 per cent or more. This process is an illustration of the fact that chemical compounds, working at atmospheric pressure, may effect a result similar to pressure distillation.

COMMERCIAL PROCESSES FOR THE PRODUCTION OF GASOLINE FROM HEAVIER HYDROCARBONS

The various processes for producing motor fuel from heavier hydrocarbons may be roughly classified as follows:

1 *The Pressure Still.* A "two-phase" cracking system. Examples are the Burton and Coast processes.

2 *The Pipe Still.* Generally a "single-phase" cracking system. Examples are the Greenstreet, Hall, and Rittman processes.

3 *The Use of Catalytic Agents at Atmospheric Pressure.* This may include reaction both in the single-phase and the two-phase systems. An example is the aluminum chloride process, which is likely two-phase to some extent.

4 *Combinations and Modifications of Two or More of the Above Methods.* The cracking may be in either single-phase or two-phase systems. Examples are the Dubbs, Jenkins, and Bacon processes.

5 *Processes Involving Principles not Included Under the Above Four Headings, but Which May Involve Similar Apparatus or the Use of Pressure.* These methods may have either single-phase or two-phase cracking systems. Examples are the proposed processes of Cherry,[2] Coast,[3] Ellis,[4] and many other processes equally unique. In the first a bipolar high-voltage, oscillating, silent electric discharge is thrown across the vapors; in the second, hot gases are passed through the oil or into contact with oil spray; and in the third, air is supplied to the cracking chamber where, by combustion with a portion of the oil, heat necessary for the cracking of the remainder is generated.

During the past eight years numerous patents involving almost every conceivable form of apparatus have been granted for the purpose of securing hydrocarbons within the gasoline range from those of higher boiling point.[5] Many of these patents seek to obviate the trouble incident to coke deposition, while others have the object in view of producing a gasoline which is comparable

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[1] Assistant Professor of Chemistry, University of Oklahoma.

Presented at a meeting of the Mid-Continent Section, Tulsa, Okla., May 28 and 29, 1920.

[2] U. S. Pat. 1,229,886, Jan. 12, 1917, and 1,327,023, Jan. 6, 1920.

[3] U. S. Pat. 1,252,401, Jan. 8, 1918, and Cosden-Coast, 1,261,215, Apr. 2, 1918.

[4] U. S. Pat. 1,295,825, Feb. 25, 1919.

[5] Some of the principles involved are as follows: The use of molten metal as a cracking agent; oil may be sprayed against an electrically heated plate within an autoclave; a perforated basket charged with metallic turnings may be disposed in a furnace; oil vapors may be subjected to progressively increasing and then progressively decreasing temperatures; superheated steam; various methods utilizing electric discharge across vapors; emulsified oil as starting material; etc., etc.

in quality with the natural product. Still others are along entirely new lines.

As early as 1865 James Young, the Scotch industrial chemist, secured a patent for the production of illuminating oil by means of pressure at about 20 lb. per sq. in.

The Pintsch gas process for the production of illuminating gas from gas oil dates back to the seventies in its commercial applications in the United States. As usually carried out at atmospheric pressure, the oil is passed by gravity into cast-iron retorts heated to bright redness. In the upper chamber of the retort oil is vaporized, while in the lower one cracking takes place. The vapors then traverse a tar seal, condenser, purifier, and meter, and are stored in a gas holder at a pressure near that of the atmosphere. The gas is finally compressed to 12 or 14 atmospheres in heavy welded tanks ready for delivery. One gallon of gas oil will produce from 60 to 75 cu. ft. of gas and when the product is compressed at the last stage a liquid known as "Pintsch gas drips" collects to the amount of about 2 or 2½ gal. per 1000 ft. of gas compressed. This liquid, while quite volatile, is very unsaturated and entirely unsuitable as motor fuel.

Benton's Apparatus for the production of illuminating oils from residual oils was patented in 1886 but was never used commercially. A pipe coil within a furnace is heated to a suitable temperature while the oil is forced through at a pressure of 285 lb. per sq. in. or more. The products of the reaction are released into a vapor chamber, which in turn is in communication with a condenser. At the inlet end of the coil is placed a safety valve and at the outlet a stop-cock for regulating the pressure on the coil.

In 1890 a patent was granted *Dewar and Redwood* for an apparatus which differed from that of Benton, to be used in cracking Russian residual oil to illuminating oil, but was never applied commercially because of the introduction of the starting material as fuel and its subsequent rise in price. A retort disposed in a furnace has one end in communication with a dome, the latter also being connected to a condenser. Safety valve, pressure gage, charging line and receiver are also provided, and the condenser and receiver are held under pressure. It is proposed to fill the retort partially, to distill under pressure and to collect the distillate in the receiver. Dewar and Redwood do not state what pressure gives the best results.

The Burton Process. Burton's first patent was granted in 1913 and the process is extensively used at the present time by the various Standard companies. In 1918 it was estimated that 10 per cent of the gasoline produced was by cracking, a large proportion of this being through the Burton still. The development of this process marks one of the milestones in the history of petroleum refining and its originator merits the distinction of being the first to demonstrate that pressure distillation could be done safely and practically on a large scale. In addition, Burton realized the limitations of the type of apparatus and did not attempt, in the original design, to make the operation continuous.

The original claims of Burton consisted in the distillation of petroleum under a pressure of 4 to 5 atmospheres and a temperature of 650 to 850 deg. fahr., maintaining the pressure upon the volatile products until they had traversed the condenser.

The standard Burton apparatus includes a still of 200 bbl. capacity or more, of conventional shape, so constructed that high pressures may be used. Beyond the condenser is located a safety valve which prevents the pressure from rising above a desired maximum and permits the escape of the permanent gases. Next in line is a valve where the pressure upon the distillate is released before it enters the run tank.

Modifications of the original Burton process call for introduction of the oil in the vapor line,[6] amounting to semi-continuous operation, the use of false bottoms[7] upon which the main portion of the carbon collects, and lastly a still containing internal flues.[8]

The Design and Operation of Pressure Stills. At the temperature at which the pressure still operates steel begins to decrease in tensile strength. It is therefore evident that a fundamentally important consideration lies in the material and method of construction of the stills. As an outgrowth of this need there are now firms which specialize in the construction of stills for severe usage. The walls of the stills are ½ in. to ⅞ in. thick and hammer-welded, this method of construction being claimed as superior to both riveting and to acetylene or electric welding for the purpose in view. In the operation of pressure stills the operator has before him thermometers and pressure gages, which inform him of the conditions prevailing within the various units under his control.[9] In the operation of some pressure stills using gas oil as the starting material, the distillation is continued at the average rate of 1 to 2 per cent an hour and the run is completed in 48 hours, giving a yield of 35 per cent of 450 deg. fahr. end-point gasoline. During distillation the bottom of the still is watched and if "hot spots" develop due to superheating from deposited carbon, close surveillance is maintained in order to determine if it will be necessary to close down the still before the run is completed. After each run the deposited carbon is completely removed from the still before recharging.

The Greenstreet, Hall and Rittman Processes. These processes involve cracking mainly in the vapor phase. By the Greenstreet method[10] a mixture of oil vapors and steam is passed through a coil of pipe which is heated, the products next being permitted to expand in drums of considerable size. The pressure is released at a point between the expanding drums and the condenser. The Hall process[11] in a broad way resembles that of Greenstreet but has the fundamental difference in that steam is not used and the pressure is released as the products leave the coils and enter the expanding drums. In the Rittman process[12] the cracking takes place in an upright tube containing a rod and chain, the latter being thrown against the sides of the tube when the former is revolved. The oil is fed into the tube at the top while the vapors are taken off separately from the tar pot at the bottom. All of these processes include the use of pressure.

The Aluminum Chloride Process.[13] The most conspicuous developments under this method have been carried out by McAfee of the Gulf Refining Co.[14] The oil is heated and stirred in a still in the presence of anhydrous aluminum chloride or other anhydrous salt of aluminum. Before treatment the oil must be freed from water and a quantity of the catalyst equal to a maximum of 8 per cent by weight of the charge is added before the distillation is begun. Fractionating towers are interposed between the still and the condenser so that the higher-boiling vapors may be returned to the still along with aluminum chloride which has been vaporized and carried out. The distillation is continued slowly at a temperature of 500 to 550 deg. fahr. over a period of 24 to 48 hours. By this method a yield of gasoline of 15 per cent or more may be obtained from residual oils.

Very interesting in connection with this process is the effect upon the residue remaining in the still and the character of the distillate secured. At the end of the distillation it is found that the aluminum chloride is in mechanical combination with granular coke which is easily removed, and that a heavy oil free from asphalt, and with its viscosity in no way impaired, may be separated from the coke and then utilized for the production of high-grade lubricating oils, the recovery of paraffin wax, or the manufacture of petroleum. The distillate secured by aluminum chloride treatment is water white and possesses a pleasant odor, and in order to secure the finished gasoline it is only necessary to wash the "rerun" distillate with dilute alkali and water.

By the action of anhydrous aluminum chloride on residual petroleum, sulphur compounds are destroyed and possibly nitrogen and oxygen compounds such as naphthenic acids as well.

The one difficulty suggesting itself as being inherent in this process is that of recovering the aluminum chloride, or of manufacturing it cheaply. McAfee has patented the two following methods for the recovery of the catalyst:

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[6] U. S. Pat. 1,199,464, Sept. 26, 1916.

[7] Humphreys patents 1,122,002 and 1,122,003, Dec. 22, 1914, and 1,119,700, Dec. 1, 1914.

[8] Clark patents 1,119,496, Dec. 1, 1914, 1,129,024, Feb. 16, 1915, and 1,132,163, March 16, 1915.

[9] Liquid meters are sometimes placed on the run lines.

[10] See Petroleum Age, 6 (1919), 66.

[11] See Lomax, Jour. Inst. Pet. Tech., 3 (1916), 36.

[12] See Bureau of Mines Bulletin 114 and Technical Paper 161.

[13] See Jour. Ind. Eng. Chem. 7 (1915), 737.

[14] Ibid.

By the first method the aluminum chloride present in the coke is dissolved in water. The solution is then evaporated and heated moderately, when the hydrated salt is broken up into aluminum and hydrochloric acid. The alumina, when mixed with carbon and calcined in the presence of dry hydrochloric-acid gas, reacts to form aluminum chloride, hydrogen, and oxides of carbon.

By the second method the residual coke is heated in an atmosphere of chlorine, when the anhydrous salt is volatilized and carried away by the chlorine vapors.

Finally, it is of interest to introduce one of McAfee's tables on the treatment of 34 deg. Baumé Oklahoma crude petroleum, showing the comparison of the aluminum chloride process with that of the customary method.

	Per Cent of Crude Oil:	
	$AlCl_3$ Process	Usual Process
Gasoline	34.82	12.50
Kerosene	29.47	41.00
Gas oil	5.36	35.00
Residual oil	14.07	9.00
Sum of products	83.72	97.50
Loss	16.28	2.50
	100.00	100.00

While the above table is not representative of the actual amount of gasoline procured at the present time from the average Oklohoma crude petroleum, still the data may serve for making comparisons. At this time the average Oklahoma crude is being refined to about 20 per cent of straight-run gasoline and 17 per cent of kerosene.

Other Processes. Three methods which have recently come into prominence because of favorable reports concerning their operations, are those of *Dubbs, Jenkins,* and *Bacon.*

The design and operation of the *Dubbs plant* is given in the report of a committee of the Western Refiners' Association to its members. Extracts from this report are quoted as follows: "The plant proper consists of a cracking coil made up of ten lengths of 4-in. extra heavy lap-welded pipe, each 20 ft. in length, jointed on the ends by return bends. This coil of 4-in. pipe is placed horizontally in a furnace in two rows, six of the pipes being in the lower row and four in the upper row. The furnace temperature is maintained at approximately 1540 deg. fahr. The outlet of the 4-in. coil is connected to an expansion chamber which consists of four 20-ft. lengths of 10-in. common extra heavy pipe. These pipes are connected in series by means of return bends so as to form an expansion chamber approximately 80 ft. long. These 10-in. pipes are positioned horizontally in a chamber and are not heated, but insulated on the outside to prevent loss of heat by radiation.

"The raw oil is fed into one end of the 4-in. coil by means of a force pump, and as the oil passes through it is heated to about 820 deg. fahr. and is then discharged from the other end into the 10-in. expansion pipes, which are maintained approximately half full of oil. The vapors are liberated from the oil and pass up through connecting goose necks to a manifold; then to vapor lines leading to a spiral vapor condenser, and finally into a water-cooled condenser. A pressure of about 135 lb. per sq. in. is maintained on the entire apparatus. The unvaporized portion of the oil in the 10-in. coil is continuously drawn off from the end of the last unit."

In regard to the Dubbs process, it should be noted that the cracking takes place in a two-phase system.

The summary at the top of the next column gives the results of a test run of 168 hours' duration.

Total gas oil treated	20,952 gal.
Total uncondensable gas	25,851 cu. ft.
Fuel used[15]—equivalent of 3677 gal. of 14 Bé. fuel oil.	
Products (per cent yield of original oil charged):	
Gasoline (440 end point) (58.59 Bé.)	26.29 per cent
Kerosene (40-41 Bé.)	14.11 per cent
Pressure distillate bottoms (31-32 Bé.)	27.19 per cent
Residuum (13-14 Bé.)	24.71 per cent
Loss	7.70 per cent
	100.00

In the *Jenkins process* an apparatus is used resembling the water-tube boiler. The tubes in the latest installation are 2½ in. outside diameter, and cold-drawn. The furnace is of the vertical baffle type with Dutch oven, no heat coming in direct contact with either the longitudinal or traverse drums. The operation of the process is continuous and the oil is circulated mechanically. The safe limit of operation (with the type of starting material being used) has been found to be when a volume of oil equal to 14 times the changing capacity has been passed into the apparatus. Working under these conditions it is claimed that the still has long life and that the time of cleaning is only five minutes per tube. In closing down after a run the reduction of temperature is accomplished gradually by forcing more charging oil into the apparatus under complete mechanical circulation, thus eliminating undue stresses or strains which might be caused by a sudden temperature drop. Mr. Jenkins contributes the following data in connection with a run of 46 hours, using pressure distillate gas oil[16] from Homer crude as the starting material:

Total oil circulated	17,130 gal.
Overhead pressure distillate	11,600 gal.
Fuel used—48,000 cu. ft. of city gas (natural).	
Products (per cent yield of original starting material):	
Gasoline (118 I.B.P., 460 end point)	24 per cent
Kerosene	29 per cent
Steam still bottoms	14 per cent
Pressure still bottoms (52 vis. Saybolt at 100 deg. fahr. and when treated, 4½ color)	27 per cent
Total loss	6 per cent

The pressure used in the above run varied from 105 to 110 lb. gage; temperature, 700 to 710 deg. fahr.

The *Bacon process* was developed under the direction of Raymond F. Bacon and Benjamin T. Brooks at the Mellon Institute of Industrial Research. As originally designed some difficulties were encountered during operation because of coke deposition on the tubes; but according to the latest information certain improvements have made the process appear very promising. The "cracking" is carried out in a vertical tube 20 ft. in length and 6 in. to 19 in. in diameter, the oil level being maintained at the top of the heated zone and the process operated continuously. The oil inlet and vapor outlet are located at the top of the tube. The lower end of the tube is connected to a drum into which the tar and coke settle and are drawn off from a pipe at the bottom. When operating an apparatus of this type, coke accumulates very slowly on the metal surface in the cracking zone and in addition a large heating surface is exposed to the oil. The pressure specified is from 60 to 300 lb. per sq. in., but preferably 100 lb. The yields of gasoline (56 Bé.) claimed for various oils are as follows:

Oklahoma gas oil (32 Bé.)	45 per cent
Mexican fuel oil (12 Bé.)	50 per cent
California fuel oil (14 Bé.)	47 per cent
Caddo heavy crude (12-14 Bé.)	48 per cent

Deposition of Coke During Cracking. It has already been mentioned that one of the most serious difficulties encountered during "cracking" is the deposition of coke. Unless removed from the walls of the apparatus very soon after its formation, the coke produced becomes very hard and seems to unite with the metal. Superheating (hot spots), consequent softening of the metal and finally "blowing out" may be the result of this condition. A majority of the processes include, among other things, methods of eliminating the coke from the heating surface. Thus the Burton process involves a modification in which false bottoms are used, the Rittman process a revolving rod and chain, the Bacon process vertical heating surface in the presence of liquid, and so on.[17] One patentee specifies the use of steel balls which are passed intermittently through the "cracking" tube.

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[15] Consumed during the run.

[16] It should be noted that this starting material has already been once through the process.

[17] In some refineries it is the practice simultaneously to agitate the oil slightly and to scrape the bottom of the still by means of a sweep with chains attached.

(*Continued on page* 426)

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

Wind-Tunnel Studies of Aerodynamic Phenomena
Mechanical Screenless Air Filters
Raschig Rings in Valves
Stresses Caused by Cold Rolling
Surface Combustion, Mixture Regulation in
Automatic Mixture Proportioners for Surface-Combustion Furnaces
Fusain and Coal Dust
Chantraine Metallurgical Furnaces
Polymultiple Flame Combustion in Metallurgical Furnaces
Ozone Concentration in Ventilation
Initial Temperature and Physical Properties of Steel
Obturators in Internal-Combustion Engines
Turner-Moore Motor-car Engine
Accentuated Valve Inclination in Motor-car Engines
Bureau of Standards Altitude Testing Laboratory
Rate of Flame Propagation, Measurement of
Viscosity of Lubricants, A. S. T. M. Proposed Standard Test for
Diesel Marine Machinery, Trends of Design
Universal Joint, Mechanics of
Flywheel Effect, Synchronous Motors Connected to Reciprocating Compressors
Schneider 155-mm. Gun
Thrust Boring in Earth
Stability of Motor Omnibuses

AERONAUTICS

Wind-Tunnel Studies in Aerodynamic Phenomena at High Speed, F. W. Caldwell and E. N. Fales. A great amount of research and experimental work has been done and fair success obtained in an effort to place airplane and propeller design upon an empirical basis. However, one cannot fail to be impressed by the apparent lack of data available toward establishing flow phenomena upon a rational basis, such that they may be interpreted in terms of the laws of physics.

With this end in view it was the object of the authors to design a wind tunnel differing from the usual type especially in regard to large power and speed of flow, which involves features whose suitability cannot be predicted. After all available information has been secured on full-size and model wind tunnels in various parts of the world, there remains much obscurity about the airflow phenomena. It is the assumption of Dr. George de Bothezat that the type of air flow which establishes itself is governed by the stresses set up in the air passing the aerofoil. The unit stresses increase as the velocity rises, and it is easy to conceive that a given type of flow is possible only so long as the shearing stresses developed in the fluid do not exceed a certain magnitude, which depends on the value of the viscosity coefficient.

Experimental investigation of the flow has heretofore been rather unsuccessful because of lack of adequate methods. The writers laid out the design of the McCook Field wind tunnel to investigate the scaling effect due to high velocities of propeller aerofoils. During the course of the experiments, however, it was found possible to visualize the air flow by the following method: The velocities of the air flow discovered by the writers offer a solution to one of the fundamental problems of aerodynamics. This problem is the quantitative empirical measurement of the phenomena of fluid dynamics pertaining to flight and air flow. The method described in the report for visualizing air flow depends upon the fact that the moisture in the air condenses as a fog when the temperature is reduced to the dewpoint, provided that there is a solid or liquid nucleus to start the condensation. In the McCook Field wind tunnel the temperature drop is brought about through expansion of the air during acceleration, due to a drop of pressure of 100 in. of water. The relative humidity of the atmosphere can be artificially raised if too low, and the necessary nucleus for condensation is provided by the model tested. Flow vortices become readily visible, and the report contains many photographs showing the air flow past an aerofoil under different conditions.

In this connection, attention is called to the paper by the same authors presented at the Spring Meeting of the A. S. M. E., and given in abstract form in Mechanical Engineering for April 1920, p. 213 (National Advisory Committee for Aeronautics Report No. 83, 52 pp., 42 figs., *eA*)

AIR MACHINERY

German Screenless Air Filters

Mechanical Screenless Air Filters, Ernst Preger. There are four ways of filtering air. One is to pass it through a screen so fine that the dust will be kept out. The second way is to pass it through a liquid, which in this case acts as a screen of infinitely fine mesh. The third method is to pass the air through an electrical screen, the mesh of which is constituted by lines of electric force. This is the Cottrell system of dust precipitation, which is very effective under certain conditions. The fourth way is to interpose in the path of the flowing air mechanical obstacles which will not interfere to any very material effect with the flow of air itself, but will cause precipitation or separation of the heavier particles such as dust. A number of devices belonging to this fourth class are described in the present article.

In the air filter of the Balcke Machine Co. of Bochum, Germany, Fig. 1, the air flows between several rows of vertical wooden planks staggered and located at angle of 45 deg. with respect to each other, as shown in the drawing. Because of the frequent changes of direction the dust particles are projected against the wooden planks and washed off them by the water flowing over their faces. Because of this arrangement, it is necessary to clean the planks. Fig. 2 shows a Balcke cleaner capable of handling 24,000 cu.m. (847,300 cu. ft.) of air per hour.

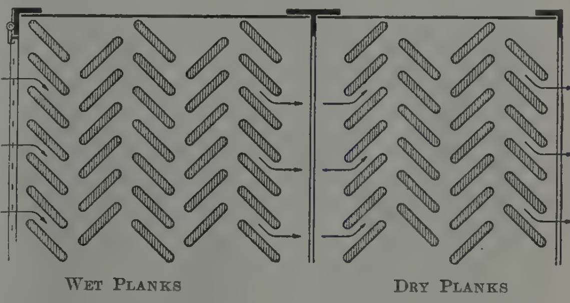


Fig. 1 Balcke Air Filter (Section through the Planks)

Water is raised to the top of the cleaner by pump *A* and is distributed over the planks *N* by the trough *B* and hopper *C*. The water accumulates at *D* and may be used for purposes where the presence of dirt in the water is not injurious.

Back of the wet planks *N* are located several rows of dry planks *P*, the purpose of which is to catch the water particles carried off from the wet half of the filter. It has been found in practice that these planks remain very nearly dry, a good indication that the use of the wet filter causes only an insignificant increase in the humidity of the air. Measurements have shown that with fairly dry entering air there is an increase of humidity of from 3 to 5 per cent, and when the humidity of the entering air is considerable, there is practically no increase of humidity.

Air filters of this type are mainly used for cleaning air employed for purposes of cooling, since there the variation of humidity is of lesser importance than, for example, with air compressors. As advantages for this type of filter are claimed the low resistance in the filter, the elimination of filter cleaning and the absence of fire danger from the accumulation of dry dust.

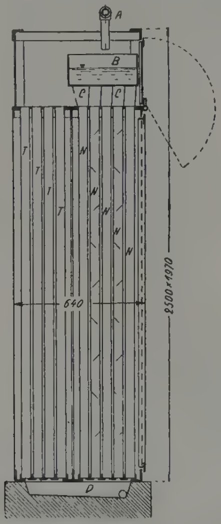


FIG. 2 BALCKE AIR FILTER IN SECTION

The next mechanical air filter described is the Viscin filter of the German Air Filter Construction Co. of Berlin. The active part of the Viscin filter consists of a frame filled with so-called Rachig rings of about 14 mm. (0.56 in.) height and the same diameter. These rings are wetted with a liquid called viscinol, which is claimed to be very sticky and little subject to deterioration. This type is not described in detail as its operation is evidently dependent on the use of a particular liquid used in wetting the rings.

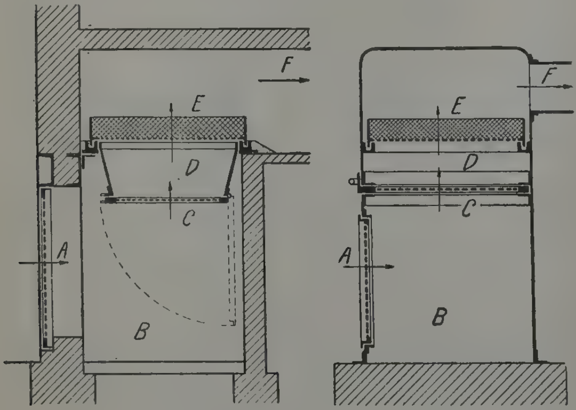


FIG. 3 MOELLER AIR FILTER

The Moeller filter, Fig. 3 (K. & Th. Moeller, Brackwede, Germany), consists also of a frame filled with Rachig rings, but in this instance the rings are not wetted. The air enters through a perforated sheet-iron wall *A*, its velocity in the chamber *B* is considerably reduced and there occurs further a sharp change in direction of flow which causes the precipitation of the larger particles of dust. The medium-size particles of dust are held back by the screen *C*. *E* is a horizontally located container filled with Rachig rings which hold back the finest particles of dust. The air comes out at *F*. Because of the three-stage method of separating the dust, namely, at *D, C* and *E*, a high degree of filtering is obtained notwithstanding the fact that no wetting of rings is resorted to. On the other hand, the dimensions of the air filter have to be made larger than in wet filters. Also the filters have to be cleaned every two or three months.

Strictly speaking, the Moeller filter does not belong to the class of screenless filters as a screen is used. It performs, however, secondary functions. (Stofflose Luftfilter, *Werkstatts Technik*, vol. 14, no. 3, Feb. 1, 1920, pp. 71-73, 16 figs., *d*)

BUREAU OF STANDARDS

A NOTE ON STRESSES CAUSED BY COLD ROLLING, H. M. Howe and E. C. Groesbeck. The experimental data here presented show that a given amount of reduction by rolling causes less residual stress in the metal rolled if it is brought about by a large number of light drafts than if by a smaller number of heavy ones. This is shown by means of the curvature induced in each of a pair of superposed strips when they are simultaneously reduced in thickness by rolling, with varying reductions.

The result is attributed to the greater skin friction between the metal rolled and the face of the rolls with heavy than with light reductions. Because of this greater skin friction more of the reduction occurs through the backward forcing of the deeper-seated layers, and less through the elongation of the surface of the metal in contact with the rolls. (Abstract of *Technologic Paper of the Bureau of Standards* No. 163, *e*)

FUELS AND FIRING

Mixture Regulation in Surface-Combustion Furnaces

SURFACE COMBUSTION, A. E. Blake. An extensive paper discussing the principles and describing the application of surface combustion. Only some passages of particular interest can be abstracted here owing to lack of space.

The factor of the highest importance in the perfected surface-combustion process is the production of perfect mixture or of any desired mixture to produce essential conditions within furnaces. There are several types of such automatic proportioning or mixing devices. Fig. 4 shows one type attached to the manifold upon the furnace. It is called the low-pressure system. In this case air is supplied at a maximum pressure of about 1 lb.

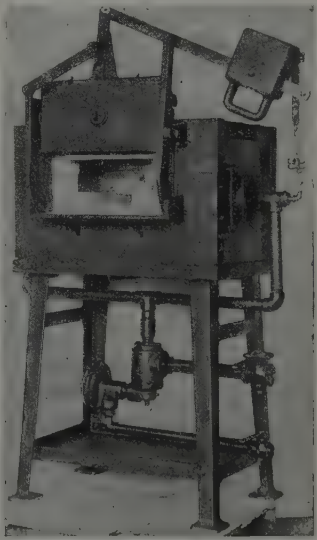


FIG. 4 SURFACE-COMBUSTION FURNACE WITH LOW-PRESSURE AUTOMATIC PROPORTIONER

per sq. in. Two cocks are provided and the air supply is governed by the upper of these cocks. The air from the chamber passes through a venturi tube to a manifold supplying the burners. Within the throat of the tube is located an adjustable nozzle and the location of this nozzle determines the proportion of air and gas in the mixture. In operation air creates suction upon the nozzle. The gas comes from a governor, the function of which is to deliver the gas at constant atmospheric pressure at all times regardless of the rate of flow. There is a diaphragm which is moved by atmospheric pressure and causes the opening of the gas entry port. Changing the air supply automatically changes the gas supply and during operation the gas cock is never touched.

In the original article another type of automatic proportioner, the so-called high-pressure type, is shown and described. No decisive steps have been taken as yet in the matter of preheating air and gas either separately or combined. This is partly due to the fact that the highest temperatures which furnaces will withstand can be secured easily without preheating, and also to the fear that preheating may cause premature ignition.

The presentation of the paper was followed by an interesting discussion which cannot be abstracted for lack of space. (Advance copy of a chapter in a book, "American Fuels," by R. F. Bacon and W. A. Hamor (McGraw-Hill) presented before the Engineers' Society of Western Pennsylvania. Abstracted from the *Proceedings of the Engineers' Society of Western Pennsylvania,* vol. 36, no. 3, April, 1920, pp. 145-174, 27 figs. in the original paper, and discussion pp. 175-204, *g*)

Coal Dust and Fusain, F. S. Sinnatt, H. Stern and F. Bayley. Investigation of the composition of fusain and the amount present in the dust produced during the working of the coal at the colliery, with particular reference to Lancashire coal fields.

The investigation is being continued with a special object of determining, among other things, the properties of the fusain with special reference to the temperature at which it will ignite and the influence of fusain upon the general properties of the coal or coal dust in which it occurs.

Fusain is a jet-black powder which causes a black and dirty smudge on the skin. It has a needle-like structure different from particles of bituminous coals of the same degree of fineness. It ignites with considerable ease at a low temperature and continues to smolder at a dull red heat. It may smolder for a long time without the production of flame or the evolution of compounds having an odor, which adds to the dangers associated with the composition of fusain, as practically no indication is afforded of the substance being on fire.

The following experiments indicate the manner in which fusain burns: A briquet measuring 4 in. by 4 in. by 9 in. was made by mixing fusain with water; it was dried at a temperature of about 105 deg. cent. and allowed to stand for one week. The briquet was then placed on a stone slab and the tip of one corner heated to redness by means of an ordinary match. The briquet was allowed to remain undisturbed, and in about an hour the whole of it was consumed without the production of smoke or flame; there was no evidence of combustion except a faint, pleasant aromatic odor resembling that of pitch pine. The mass smolders internally, for when the surface is removed a glowing dull-red zone is exposed. The residual substance, in certain experiments, was a finely powdered coke—in fact, it appeared as if the volatile matter only had been consumed; in others the residual substance was the ash. A briquet of similar dimensions containing 50 per cent of fusain and 50 per cent coal acted in the same manner, and again practically no odor or smoke was produced.

When fusain is carbonized a coke is produced having an appearance practically identical with that of the original substance. This coke is jet black and is quite deficient in caking power.

It is of interest to note that dust from a dust collector of which 95 per cent by weight would pass through a sieve of 1/90 mesh was found to contain about 49 per cent fusain. (*Lancashire and Cheshire Coal Research Assn. Bulletin* No. 5, 1920, 19 figs., *ep*)

FURNACES

Polymultiple Flame Combustion in Metallurgical Furnaces

Chantraine Metallurgical Furnaces. Description of a new type of furnace in which combustion is carried on by means of a large number of separate jets of flame.

In conventional metallurgical furnaces the firing is effected by means of flame obtained through a simultaneous admission of the air and gas. With these systems the high temperatures needed for the metallurgical process can be maintained only in certain definite sections of the furnace, which, because of this, has a very variable régime throughout the combustion chamber and this leads to trouble, both as a result of the irregularity of distribution of heat and because of oxidation. It is claimed that the system described in this article, which the author calls "polymultiple flame" combustion, avoids these defects.

The characteristic features of the Chantraine method are:

1 There is a reservoir of hot air, usually produced by making the roof of the combustion chamber double and providing for an interspace through which pass the conduits leading the air to the combustion chamber from the hot-air regenerator.

2 A number of orifices are provided in the lower roof of the hot-air reservoir, these orifices acting as tuyeres to admit air to the combustion chamber.

3 A sheet of combustible gas floats under the perforated roof of the combustion chamber; this sheet of gas is fed in slowly and continuously through gas conduits from the gas producers.

4 A continuous apparatus is provided for recuperating the combustion-chamber waste heat and to employ this latter for a preliminary preheating of the secondary air.

The operation of the system is based essentially upon the following: The air under pressure, whether natural or artificial, passes through the multiple tuyeres and then through the sheet of gas slowly and continuously fed to the roof of the combustion chamber; in doing this, the air creates a bundle of flaming darts, a compact bundle directed toward the material to be heated. The products of combustion are e hausted solely by the pressure in the combustion chamber.

The theory of this system of combustion is as follows: If a jet of gas passes into the air, as happens in conventional systems, combustion occurs on the periphery of this jet and this periphery produces heat radiations, the majority of which pass into the air which is diathermanous while the commercial combustible gas is athermanous.

On the other hand, if a jet of air is made to penetrate into the atmosphere of ordinary combustible gas so as to produce the same number of calories per second, the periphery of the jet also emits heat and light radiations and a great majority of the heat radiations go into the air of the jet, preheating it all the more the less air there remains for the oxidation of the gas, which latter is athermanous. As a result of this, the tip of the flame of air in a gas atmosphere is many times hotter than the tip of the flame of gas in an air atmosphere and the combustion even with the low initial temperature is practically perfect with the minimum access of air, while in the opposite process (gas going into an air atmosphere) the excess of air must be very large.

Furthermore, in conventional furnaces the radiation spreads equally over the roof and the side walls as well as over the floor of the furnace and the material located thereon. In polymultiple-flame furnaces the sheet of gas floating against the roof protects it as well as the walls against the radiations from the bottom of the furnace and the melting material. Also since the roof of the furnace is equipped with a number of orifices through which a constant flow of air takes place, the refractory material of the roof is never permitted to attain a temperature high enough to soften it or melt it.

Uniformity of temperature distribution in the furnace is secured because each jet projects on to the part of the flow whereon it projects a certain number of calories.

The analyses of exhaust gases obtained when this system was employed have given contents of carbon dioxide very closely approaching the theoretical maximum. This fact is explained in the following manner. As the tips of the jets of air are very highly superheated, they consume all the oxygen which they contain during the passage through the fairly stagnant and thick sheet of combustible gas, the temperature of which increases as the flame nears the floor of furnace.

Fig. 5 shows the general construction of the Chantraine furnaces. As regards the temperatures obtainable with this system, it is stated that the temperatures at the tip of the individual jets are close to the theoretical temperature of combustion. Since the jets cannot radiate their heat through the sheet of gas through which the air flows, all the heat is retained and is used to raise the final temperature of combustion.

In ordinary furnaces a certain amount of metal is lost through oxidation. In the Chantraine system the metal is separated from the oxidizing agents by a thick and uninterrupted sheet of neutral gases (products of combustion) the oxygen of which has been completely neutralized during the passage of the flame through a very hot sheet of reducing gases. This oxygen itself having been heated to an exceeding high temperature. Furthermore, the pressure existing in the combustion chamber prevents the possibility of the entrance of outside air. It is claimed that a fuel economy as compared with conventional types of furnaces may be secured as high as 40 per cent, with lower metal losses and lower maintenance costs. This construction is particularly suitable for reheating furnaces, for steel-melting furnaces, etc. (*Le Génie Civil*, vol. 76, no. 14, April 3, 1920, pp. 336-337, 2 figs., *dA*)

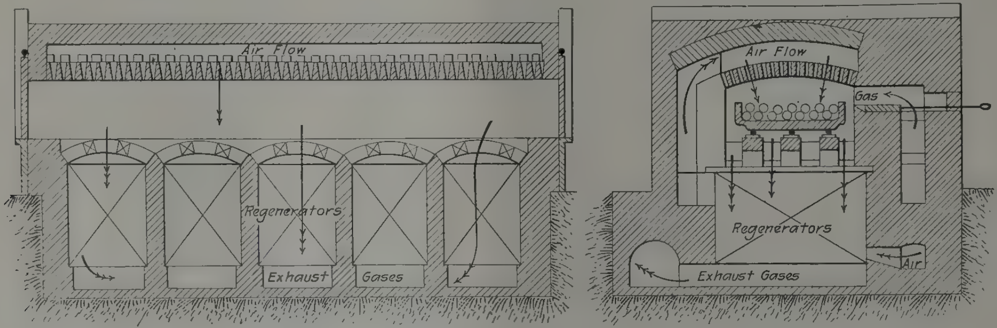


FIG. 5 CHANTRAINE "POLYMULTIPLE FLAME" METALLURGICAL FURNACE

HEATING AND VENTILATION

THE SIGNIFICANCE OF ODORLESS CONCENTRATION OF OZONE IN VENTILATION, E. S. Hallett. This paper is essentially a companion to the paper by the author abstracted in the April issue of MECHANICAL ENGINEERING (p. 244).

The author states that chemical methods of determination of ozone cannot be conveniently utilized for ventilation purposes—(1) because the apparatus must be used often under conditions where chemical tests are not available, and (2) because the concentration of ozone for ventilation is too low for such tests. Therefore the odor remains the only indicator of excessive concentration, notwithstanding the fact that only a rough approximation of measurement is thereby made available.

Ozone in ventilation is not a stimulant and its refreshing action and the freedom from languidness are only normal conditions due to freedom from depression resulting from odors and excessive heat. Furthermore, the effects of ozone do not wear off rapidly, and are not psychological merely, as excellent results have been observed in schools where teachers and pupils were unaware of the presence of ozone.

Interesting data are presented concerning the influence of ozone on the degree of susceptibility to influenza. During the epidemic of 1918 the writer accidentally discovered that very few motormen of the street-car service contracted the disease, which was ascribed to the action of ozone emitted by the car controllers.

It was also found that employees in offices having ozone air purification proved to be remarkably immune to influenza. This is explained by the fact that ozone increases the oxyhaemoglobin content of the blood and thereby increases the resistance of the body to all disease. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 26, no. 4, May 1919, pp. 423-425, *gp*)

HEAT TREATMENT

THE EFFECT OF INITIAL TEMPERATURE UPON THE PHYSICAL PROPERTIES OF STEEL, J. H. Andrew, J. E. Rippon, C. P. Miller, and A. Wragg. Discussion of the effects which variation in initial temperature has upon the position of the resulting transformation point in certain nickel, chromium, and nickel-chromium steels.

The volume change at the normal transformation points as shown by the dilatometer has been found to be composed of two changes working in opposition, namely, allotropic change and change due to the carbide. The latter change in steels of high carbon content is not completed at the ferrite or carbide (SE) line, but continues to a temperature depending on its composition, particularly carbon content, increasing with this. This quantity has been shown to be a measure of the molecular concentration of the carbide in solution, and controls the temperature at which the allotropic transformation takes place.

This variation in the molecular concentration is explained by the assumption that carbide dissociates at and above the temperature of the normal transformation point.

Nickel-chromium steels behave in much the same way as carbon steels, excepting that in the latter the time factor necessary to produce the same changes in the carbide is of a much lower order.

Martensite has been shown to be the product formed when the allotropic change has been depressed by dissociated carbide to a temperature at which the latter is able to exist as such in the alpha iron formed. At the temperature of the normal transformation point martensite is not formed as an intermediate phase between austenite and pearlite.

By tempering austenite in such a way that the carbide becomes partially associated, the allotropic change is able to take place on recooling, forming martensite, thus explaining the phenomenon of secondary hardening.

It has been shown that in the carbon steels experimented with, quenched at 1000 deg. cent., the iron in the product is in the alpha state. In alloy steels gamma iron is present in various proportions, particularly with high carbon content. In extreme cases alpha is entirely absent. (Paper before Iron and Steel Institute, Annual Meeting, May 6-7, 1920, abstracted from advance proof, 82, pp., 71 figs. and 1 plate of photomicrographs, *eA*)

INTERNAL-COMBUSTION ENGINEERING (See also Marine Engineering)

Obturators in Internal-Combustion Engines

Obturators Versus Piston Rings. Experiences in air-cooled engines on aircraft led in some cases to the replacement of the ordinary piston rings by an obturator, which is essentially the equivalent in metal of the cup leather used for packing hydraulic cylinders. The air-cooled cylinders of rotary engines, it was found, suffered distortion when at work owing to the leading side of the cylinder being more effectually cooled than the trailing side. As a consequence, piston rings often failed to hold the pressure satisfactorily. Any increase in their number would have involved a longer and heavier piston, and the obturator was introduced in consequence. This, as explained in an interesting and valuable paper by Mr. W. Fennell, M. I. E. E., which was read at a recent meeting of the Diesel Engine Users' Association, consisted of a flexible L-shaped ring forced against the cylinder wall by fluid pressure. At the outset the life was short, but improvements made at the works of "Engineering and Arc Lamps" increased the life from 10 hours to 60 hours, and in exceptional cases to 250 hours. Brass was the metal first employed, but a special phosphor bronze is now used. The obturator was placed near the top of the piston, but being flexible and forced by the pressure into close contact with the relatively cool wall of the liner, it did not burn. Nevertheless, it is now considered preferable to fix it some little distance below the piston head. As originally fitted the rings were split similarly to a piston ring, but a lap joint is now used and with this the obturator works well, even if the liner be worn out of truth. In consequence of the satisfactory behavior of these obturators, Mr. Fennell determined to fit one to a three-cylinder Sulzer-Diesel engine rated at 140 hp. The liners of this engine had worn badly, being far from circular and tapering to the extent of 0.1 in. It was impossible under the conditions to obtain new liners, and piston rings failed so rapidly the engine could not be run save at a prohibitive cost. It was decided accordingly to fix the three top rings of the piston and to place an obturator in the fourth groove. After a run of 100 hours without loss or blowing by, the obturator was examined. The wear was less than 1 mil, and the engine was set to work again, without replacing it. This obturator lasted 380 hours and then failed, due to wear at the lap joint. Here the motion was considerable, owing to the taper of the liner. Further experiments showed that even with these badly-worn liners the obturator might be counted on to last 300 hours, which was longer than the piston rings would stand. Further tests, Mr. Fennell stated, are in progress, and they indicate that with the liners in proper condition the life of the obturator should be well over 1000 hours. (*Engineering*, vol. 109, no. 2833, April 16, 1920, pp. 520, editorial, *g*)

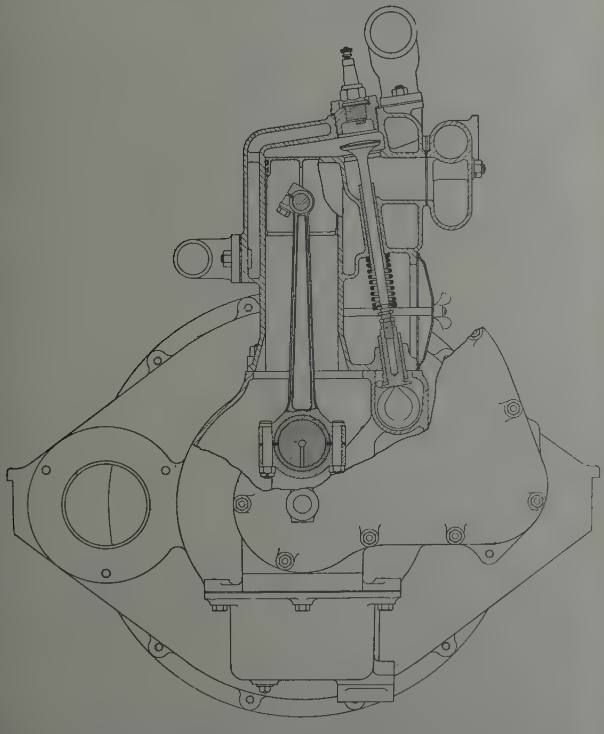


Fig. 6 Turner-Moore Motor-Car Engine (Cross-Section Showing Inclined Valves)

Motor-Car Engine with Hollow Crankshaft and Strongly Inclined Valves

Turner-Moore Motor-Car Engine. Description of the new Turner-Moore 3½ by 5-in. four-cylinder engine having some interesting features. One of these is the hollow crankshaft. It is 2 in. in diameter at all bearings. There are no oil tubes, all of the leads being drilled. The engine also has a tunnel in which are housed a camshaft and bearing points of the tappets. This construction permits the operation of the camshaft and cams in an oil bath.

Fig. 6 shows the valve arrangement with its accentuated inclination of the valves, the purpose of which is to secure better scavenging inasmuch as it permits the exhaust gases to be swept off the top of the piston directly into the exhaust passage. The inclination also permits of increased water space around the valve-stem guides and in addition gives a shorter combustion chamber.

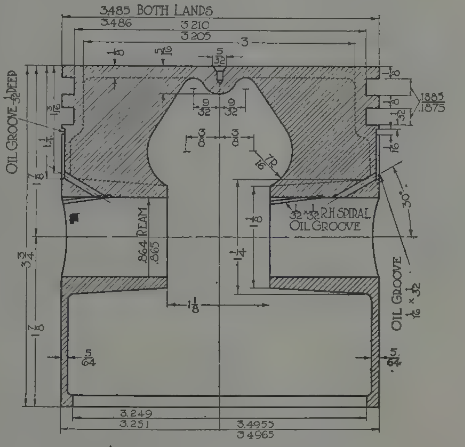


Fig. 7 Turner-Moore Motor-Car Engine (Section Showing Web Construction and Oil Relief in Pistons)

On the pressure-feed lubricating system there is a ball check and relief valve at the end of the oil line, the overflow from which lubricates the timing gears. The cylinder walls are lubricated by oil mist thrown from the connecting-rod bearings, and the remaining bearings are taken care of by direct-pressure feed.

The pistons are semi-steel and as shown in Fig. 7 are heavily webbed, the web being split at the center as to avoid distortion due to expansion. The piston has two rings at the top end. Below the lower ring there is an oil groove 1/32 in. deep around the entire piston, and at the point directly above the piston pin there is a slot cut in the side of the piston, the lower end of which is in connection with the drilled lead to the top of the piston-pin bearing. The effect of this is said to be to force oil to the top of the piston bearing on every up stroke. (*Automotive Industries,* vol. 62, no. 17, Apr. 22, 1920, pp. 946-947, 5 figs., *d*)

Bureau of Standards Altitude Testing Laboratory and Apparatus to Measure Rate of Flame Propagation

Bureau of Standards New Engine-Testing Plant, R. S. McBride, Description of the altitude testing laboratory at the Bureau of Standards. The purpose of the laboratory is to test aeronautical engines, reproducing artificially the surrounding conditions under which they have to operate at various altitudes.

During the war period the laboratory was housed in temporary buildings, but a new laboratory has just been completed. This is a substantial brick and concrete building about 50 ft. by 100 ft. The altitude chambers are so designed that conditions can be reproduced in them such as are likely to be encountered at altitudes up to 40,000 ft. These chambers are large enough to take the largest aeroplane engine.

The operation of the altitude laboratory requires a rather complicated system of controls for the engine, the air system and the dynamometers. In the new laboratory all these have been brought nearer together so that a single operator has complete control of the system without moving from his regular position of observation. It is thus possible to quickly adjust conditions for a test, carry through the observations and be ready for a new adjustment of conditions.

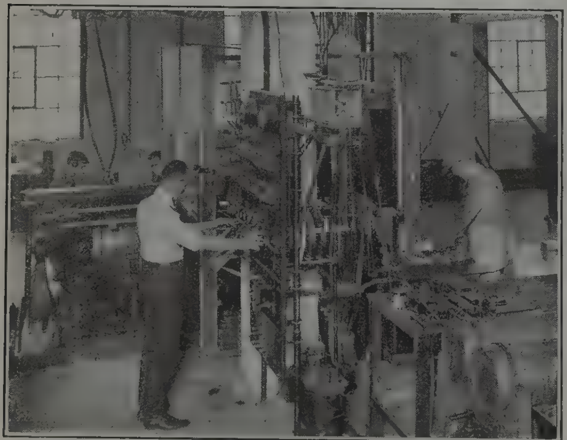


Fig. 8 Testing a Single-Cylinder Liberty Engine for Rate of Flame Travel

Other highly interesting equipment provided includes, for example, the arrangement shown in Fig. 8 to permit the study of the rate of flame propagation within the cylinder of an engine. This has been made possible by a triple spark-plug system which operates roughly as follows: At the time the flame of burning gas-and-air mixture passes over the spark plug the gases are ionized and a reduction in electrical resistance results. This permits the passage of a spark across the gap. The spark plugs are connected to a spark chronograph (which is being adjusted by the operator at the right in Fig. 8) or an oscillograph and the relative time of the passage of the flame past these three points can thus be measured (*American Machinist,* vol. 52, no. 20, May 13, 1920, pp. 1061-1063, 4 figs., *d*)

LABORATORIES (See Internal-Combustion Engineering)

LUBRICATION

Proposed Standard Test for Viscosity of Lubricants. The test was proposed as tentative in 1919 to the American Society for Testing Materials, but it has not yet been finally adopted.

According to this proposal viscosity shall be determined by means of the Saybolt standard universal viscosimeter described in a general manner and illustrated in the original text.

Viscosity shall be determined at 100 deg. fahr., 130 deg. fahr. or 210 deg. fahr., and for viscosity determinations at the first two temperatures either oil or water may be used as the bath liquid.

The discharge is measured by a standard receiving flask shown in cross-section in the original paper and the time in seconds for the delivery of 60 cc. of oil is the Saybolt viscosity of the oil at the temperature at which the test was made. (*Report of Committee D-2 on Lubricants of the American Society for Testing Materials,* preprint, 5 pp., 2 figs., *gp*)

MACHINE PARTS AND DESIGN (See Internal-Combustion Engineering)

MARINE ENGINEERING

The General Trend of Diesel Marine Machinery. According to an editorial in *Engineering,* there is at the present time no problem concerning the minds of marine engineers to a greater extent than that of the application of the Diesel oil engine to marine propulsion.

Statistics, as far as they are available, and without any data as to German construction, show that in the field of ships of greater deadweight capacity than 2000 tons considerably more than 150 are on order and in course of construction at the present time and are destined to be fitted with marine Diesel engines.

In the list of countries where this kind of work is done Denmark occupies the first place, the United States of America the second, and Great Britain the third, but it is claimed that the position of Great Britain is rapidly being improved.

A review of the type of engine being constructed goes to show that the simple single-acting 4-stroke-cycle engine is largely preferred today, and of the vessels built only some 16 per cent are to be fitted with engines of the 2-stroke-cycle type. Moreover, almost half of the 2-cycle engined ships are single-screw, whereas 90 per cent of the 4-stroke cycle machinery is of the twin-screw variety. Of all the motor vessels over 80 per cent are fitted with twin screws.

The 2-stroke-cycle engines comprise the opposed-piston types at present exclusively built in Britain, the supercharging port scavenging engine originated in Switzerland and being built now chiefly in Switzerland and Italy, and the valve scavenging engine which is now retained by only one French constructor. In America very few 2-cycle Diesel engines are in the course of construction, and Sweden, Denmark and Holland are solidly in favor of the 4-stroke cycle engine.

In Britain not only is the greatest variety of type evidenced, but also the largest engines are being constructed, the most powerful, the 4-cylinder opposed-piston two-stroke engine of 750 b.hp. per cylinder. The cylinder diameters are 580 mm. and the stroke 1160 mm., and the engine develops at 70 revolutions a total of 3000 b.hp. in the four cylinders. The largest 4-cycle engine being constructed in Britain, and also elsewhere, has cylinder diameters of 740 mm. by a stroke of 1150 mm., and runs at 115 r.p.m., developing over 3500 b.hp. in eight cylinders. The 2-cycle engines are of four and six cylinders—generally of four cylinders—and the 4-cycle engines have six cylinders, with a few exceptions where eight cylinders are employed to give the desired high power.

The British policy of trying out all types of engine is certain to lead in the end to a very favorable position, and is a very bold one and to be commended in view of the leeway which had to be made up and the lead unquestionably held by the earlier constructors of 4-cycle engines. The unfortunate and unlikely event of failure with any of the newer types cannot now, in view of the varied and long experience already piled up to the good, be taken as evidence sufficient to condemn this prime mover in respect of its suitability for marine work. (*Engineering,* vol. 109, no. 2836, May 7, 1920, pp. 617-618, editorial, *g*)

MECHANICS (See also Transportation)

The Mechanics of the Universal Joint

FORCES ACTING IN A UNIVERSAL JOINT, D. Thoma, D. E. Universal joints are used to connect shafts, the axes of which intersect at an angle of 90 deg. or less. If the shafts transmit no moment of torsion, the universal joint does not oppose the free variation of the angle of intersection of the two shafts and permits a free oscillation of one shaft axis relatively to the other about the center of the joint. This being so, it is easy to neglect mistakenly the fact that this resistance-free ability of oscillation persists only until the moment when the shafts begin to transmit a torsional moment, and that if the angle of intersection of the two shafts is other than zero, the universal joint as a rule must transmit the bending moment in addition to the torsion moment.

Even a superficial consideration will show that the universal joint actually exerts a bending moment on the shafts. Whatever may be the axis of the moment transmitted between the shafts through the means of the joint, it forms with the axial direction of at least one of the two shafts an angle equal to or more than half the angle between the shafts, so that the moment, at least with respect to one of the shafts, has a component normal to the axis of that shaft, which means a bending moment.

Since the conditions with respect to the two shafts are substantially symmetrical as a rule, both shafts will have to undergo the effect of a bending moment.

The universal joint coupling is a machine element having an extensive application, and it may be worth while, therefore, to investigate more closely the forces acting thereon. This is practically of interest in connection with certain tests on the critical speed of rapidly rotating shafts where the universal joint plays an important part.

The investigation of the forces presupposes the movements of the joint itself and of the shafts. Let us assume, as in Fig. 9, a system of rectangular coördinates such that both shafts lie in the x-y plane and that the positive z axis is located normally to the plane of the drawing and is directed upward. The angles of rotation of the shafts are measured from the position shown in Fig. 9, which may be called position A. Fig. 10 shows the general location of the coupling: The shaft I is rotated from the position A through an angle φ and the shaft II through an angle ψ in the direction of the arrow. We shall consider φ as an independent variable and shall determine ψ as a function of φ.

Let P be some point on the axis of the part of the universal joint belonging to the shaft I, and l its distance from O which is the point of intersection of the axes of the shafts and of the arms of the universal joints. The projection of OP shown in Fig. 10 is then equal to $l \cos \varphi$ and hence the coördinates of P are

$$\begin{aligned} x &= l \cos \varphi \cos \alpha \\ y &= -l \cos \varphi \sin \alpha \\ z &= l \sin \varphi \end{aligned}$$

From this it is found that the cosines of the angles α_1, β_1 and γ_1 which are enclosed between the axis of the arm of the universal joint belonging to shaft I and the axes of the coördinates are

$$\left.\begin{aligned} \cos \alpha_1 &= \cos \varphi \cos \alpha \\ \cos \beta_1 &= -\cos \varphi \sin \alpha \\ \cos \gamma_1 &= \sin \varphi \end{aligned}\right\} \ldots\ldots\ldots\ldots [1]$$

In a similar manner are found the cosines of the angles α_2, β_2 and γ_2 which are enclosed between the axis of the arm of the universal joint belonging to shaft II and the axis of coördinates, these cosines being

$$\left.\begin{aligned} \cos \alpha_2 &= -\sin \psi \\ \cos \beta_2 &= 0 \\ \cos \gamma_2 &= \cos \psi \end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

The directions of the two arms of the universal joint are not, however, independent of each other, the arms being connected with each other in such a manner that they are always at right angles to each other. The usual formula of analytical geometry of space gives therefore the relation—

$$\cos \alpha_1 \cos \alpha_2 + \cos \beta_1 \cos \beta_2 + \cos \gamma_1 \cos \gamma_2 = 0$$

If we insert into this formula the values from Equations [1] and [2], we obtain after transforming—

$$\sin^2 \psi = \frac{\sin^2 \varphi}{\cos^2 \alpha + (1 - \cos^2 \alpha) \sin^2 \varphi} \ldots\ldots\ldots [3]$$

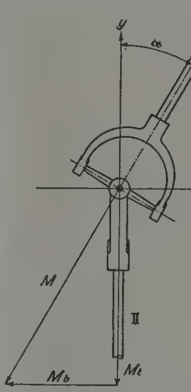
This situation may also be expressed in the form

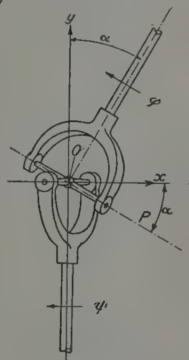
$$\tan \psi = \frac{1}{\cos \alpha} \tan \varphi \ldots\ldots\ldots\ldots\ldots\ldots\ldots [4]$$

which will be used later on in this article and which is very simple.

The Action of the Forces. For the sake of simplicity it may be assumed that the joint transmits only moments but not individual forces. This assumption is usually satisfied at least if the joints are properly manufactured and installed, or if the journals of the arms have sufficient axial play in the bearings to take up the inequalities of manufacture, and furthermore we may assume that at least one of the two shafts is displaceable in an axial direction and will not take up any forces directed along its axis. The universal joint itself is considered as lacking either in mass or weight.

It is further assumed that shaft I is the driver. The joint transmits then the moment taken from shaft I unchanged in either magnitude or direction to shaft II. The arms of the joint are rotatable in the forks on the shafts and furthermore are assumed to be rotatable without friction; the axis of the moment which the joint takes up from shaft I and the fork located thereon is, therefore, normal to the arm held in that fork; the axis of the moment equal thereto in magnitude and direction which the part of the joint transmits to the fork on shaft II, and thereby to shaft II itself, is normal to but inverse in direction with respect to the arm of the joint located in that fork. The axis of the moment transmitted by the joint is thereby determined as the normal to the two arms of the joint, or, as one may express it otherwise, is the normal to a plane passing through the two arms.





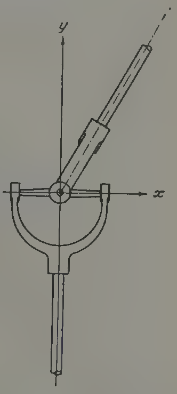


FIG. 9 UNIVERSAL JOINT IN POSITION A
FIG. 10 UNIVERSAL JOINT IN INTERMEDIATE POSITION
FIG. 11 UNIVERSAL JOINT IN POSITION B

In the position B (Fig. 11) this normal coincides with the axis of shaft II and the universal-joint coupling transmits to shaft II a pure torsion moment. In the position A (Fig. 9) the normal deviates most from the axis of shaft II, viz., by the angle α. Hence there the joint transmits to shaft II a bending moment $M_b = M_t \tan \alpha$ in addition to the torsion moment M_t. The forces acting on shaft I in both positions are just the reverse of this.

In order to estimate numerically the moments occurring in the intermediate positions, we shall designate the angles between the normals to the arms of the joint with the axes of coördinates by letters λ, μ and ν. We shall further designate the total moment transmitted to shaft II by M, the component of M in the x direction by M_x (= bending moment about x-axis) and the component (occurring in intermediate positions) in the z direc-

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tion by M_z (= bending moment about the z-axis). It is then obvious that

$$M_t = M \cos \mu,\ M_x = M \cos \lambda,\ M_z = M \cos \nu$$

In addition to the torsion moment M_t, the transmission of which is the purpose of employing the joint, there are transmitted to shaft II also the bending moments—

$$\left.\begin{aligned} M_x &= \frac{\cos \lambda}{\cos \mu} M_t \\ \text{and} \qquad & \\ M_z &= \frac{\cos \nu}{\cos \mu} M_t \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots [5]$$

It is necessary then to determine the values of cos λ, cos μ and cos ν. But according to the definition given above λ, μ and ν are the angles which the normals to the arms of the joint (α_1, β_1 and γ_1 and α_2, β_2 and γ_2) make with the axes of the coördinates; these angles are then determined by known equations of analytical geometry, viz.:

$$\cos \lambda = \cos \beta_1 \cos \gamma_2 - \cos \beta_2 \cos \gamma_1$$

and similar equations for the other two angles. In these equations account has been taken of the fact that the directions given by α_1 β_1 γ_1 and α_2 β_2 γ_2 are themselves at right angles to each other. If we insert into these equations the values from Equations [1] and [2] we obtain

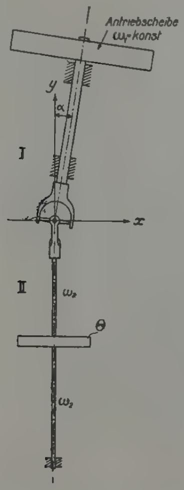


FIG. 12 UNIVERSAL JOINT DRIVE SUCH AS HAS BEEN INVESTIGATED BY O. FOEPPL

(*Antriebschiebe* ω_1 = *Konst.*, Driving Pulley ω_1 = Constant.)

$$\begin{aligned} \cos \lambda &= -\cos \varphi \cos \psi \sin \alpha \\ \cos \mu &= -\sin \varphi \sin \psi - \cos \varphi \cos \psi \cos \alpha \\ \cos \nu &= -\cos \varphi \sin \psi \sin \alpha \end{aligned}$$

where Equation [4] holds good for the relation between φ and ψ. By inserting these values into Equation [5] we obtain the comparatively simple formulae—

$$M_x = \frac{\sin \alpha \cos \alpha}{\cos^2 \alpha + \tan^2 \varphi} M_t \ldots\ldots\ \ldots\ldots\ldots [6]$$

$$M_z = \frac{\sin \alpha \tan \varphi}{\cos^2 \alpha + \tan^2 \varphi} M_t \ldots\ldots\ldots\ldots\ldots [7]$$

As an example of the application of the above, may be investigated the system shown in Fig. 12, which is of particular interest because of the observations therein published by O. Foeppl in the *Zeitschrift des Vereines deutscher Ingenieure*, 1919, p. 867.

The moment of inertia of the driving-belt pulley is so large as compared with the moment of inertia θ of the small flywheel pulley that the angular velocity of shaft I, which is ω_1, may be considered as being constant. The angular velocity of shaft II is $\omega_2 = \omega_1 \frac{d\psi}{d\varphi}$ and its angular acceleration is

$$\frac{d\omega_2}{dt} = \omega_1 \frac{d}{dt}\left(\frac{d\psi}{d\varphi}\right) = \omega_1 \frac{d}{d\varphi}\left(\frac{d\psi}{d\varphi}\right)\frac{d\varphi}{dt}$$

and since $\frac{d\varphi}{dt} = \omega_1$

$$\frac{d\omega_2}{dt} = \omega_1{}^2 \frac{\alpha^2 \psi}{d\varphi^2}$$

The moment of torsion transmitted to shaft II by the joint in order to cause it to move is therefore

$$M_t = \theta \frac{d\omega_2}{dt} = \theta \omega_1{}^2 \frac{d^2\psi}{d\varphi^2} \ldots\ldots\ldots\ldots\ldots [8]$$

The bending moments M_x and M_o can then be derived from Equations [6] and [7]. In order to carry out the computation we must first determine $\frac{d^2\psi}{d\varphi^2}$ by double differentiation of Equations [3] and [4]. By substituting this value in Equation [8] and by substituting the value of M_t thus obtained in Equations [6] and [7], we obtain for M_t, M_x and M_z rather complicated expressions which may, however, be materially simplified when the angle α is not very large, as then one may neglect the expression $(1 - \cos \alpha)^2$. This is permissible even for fairly large angles as, for example, $(1 - \cos 8.5 \text{ deg.})^2 = 0.00012$. If this is done we obtain

$$\begin{aligned} M_t &= -2\,\theta\,\omega_1{}^2 (1 - \cos \alpha) \sin 2\varphi \\ M_x &= -\theta\,\omega_1{}^2 \sin \alpha\, (1 - \cos \alpha)\, (\sin 2\varphi + \tfrac{1}{2} \sin 4\varphi) \\ M_z &= -\tfrac{1}{2}\,\theta\,\omega_1{}^2 \sin \alpha\, (1 - \cos \alpha)\, (1 - \cos 4\varphi) \end{aligned}$$

From the last two equations it appears that the shaft II receives through the universal joint powerful impulses tending to produce bending with a frequency double and quadruple the number of revolutions, and these impulses create new critical speeds and may entirely overshadow other effects. (*Schweizerische Bauzeitung*, vol. 75, no. 17, Apr. 24, 1920, pp. 187-188, 4 figs., *tA*)

Gyroscopic Phenomena in Synchronous-Motor Drive of Reciprocating Compressors

FLYWHEEL EFFECT FOR SYNCHRONOUS MOTORS CONNECTED TO RECIPROCATING COMPRESSORS, R. E. Doherty. From an analysis of mechanical and electrical conditions of operation of synchronous motors connected to reciprocating apparatus it appears that there is a very close relation between the flywheel effect and the proper design of the motor.

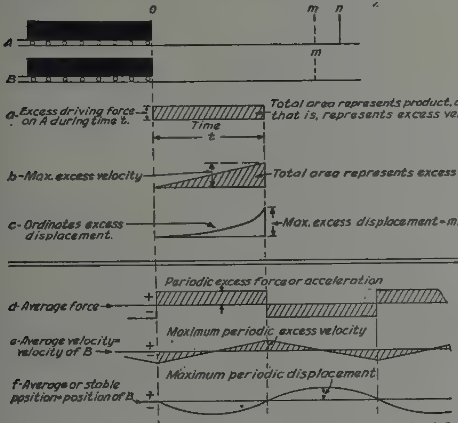
Two motors of similar design are, for example, installed on different types of compressors; one operates well and the other does not. It appears, for example, that the motor gives trouble from surging and hunting. Then the flywheel is removed and the operation becomes satisfactory. In another instance, however, in which surging or hunting occurs, the flywheel is added and the trouble is cured. It would appear, therefore, that there can be either too much or too little flywheel and the author offers a method of solving this problem.

To do this, an analogy is offered first, such as Fig. 13, where two trains are assumed to be running side by side at constant speed and abreast of each other.

Under these conditions the driving force of the trains is exactly equal to the opposing forces of friction, windage, etc., and the position may be called "stable position."

Assume, however, that at an instant designated by O the driving force on train A is suddenly increased by an amount indicated in the figure and that after a time period t, this excess is suddenly removed. The presence of this added force will affect the velocity and relative displacement of trains A and B in the following manner. The excess force a being consumed entirely in the acceleration of the train may be used to represent graphically the product of acceleration × time, that is, excess velocity. But the result of its application will be that while train B reaches point m, Train A will have gone further, viz., to point n. The excess displacement mn is represented by the maximum ordinate at the end of curve c, and the idea is that it is possible from the curve of unbalanced force impressed upon a mass to find the change in both velocity and displacement simply by integrating the area of the loops in the unbalanced force diagram. The first integration gives velocity and the second gives displacement.

From this the author proceeds to the consideration of a case where, instead of the momentary excess force described above, a periodically varying force is applied. The resultant curve of velocity will then be as shown at e and the displacement curve at f shows the position of train A first ahead and then behind the "stable" position.


o
m
n
A
m
B
a-Excess driving force on A during time t.
Total area represents product, acceleration X time, that is, represents excess velocity.
Time
t
b-Max. excess velocity
Total area represents excess displacement.
c-Ordinates excess displacement.
Max. excess displacement = mn
Periodic excess force or acceleration
d-Average force
+
−
Maximum periodic excess velocity
e-Average velocity = velocity of B
+
−
Maximum periodic displacement
f-Average or stable position = position of B
+
−

Illustrating the effect of a variable applied force and a constant force consumed by load.

FIG. 13 DIAGRAMS SHOWING HOW PERIODIC RELATIVE DISPLACEMENT OF TWO TRAINS IS DERIVED FROM CURVE OF UNBALANCED DRIVING FORCE

One part of the problem of determining the proper flywheel effect for synchronous motors direct-connected to reciprocating compressors is illustrated in this way,—that it is required to find what mass train A must have in order to limit to a definite amount the plus and minus displacement, as shown in f, when a given periodic variation in the driving force is impressed upon train A.

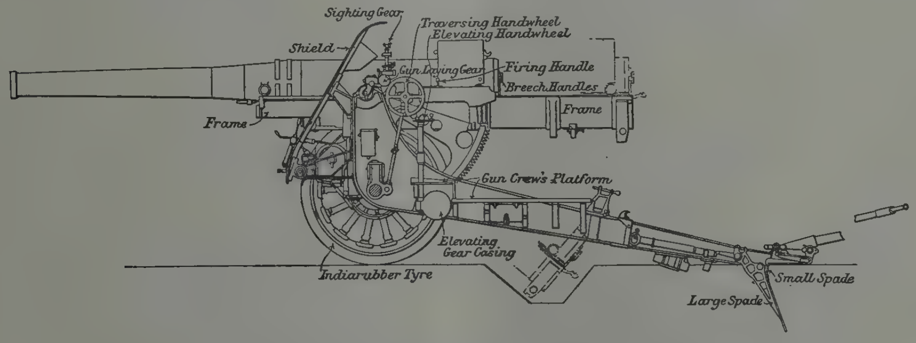


FIG. 14 SCHNEIDER 155-MM. GUN IN FIRING POSITION

A synchronous machine driving an air compressor will have a pulsating speed on account of the pulsating torque of the compressor, and the variable torque on the motor will cause it to displace first ahead and then behind "reference positions" which might be marked on a similar motor running at constant speed. For electrical reasons, however, it is necessary to place limits to this displacement or deviation, and the real problem is to determine how much flywheel is required to keep the angular displacement within given required limits which can be worked out from the turning-effort diagram of the compressor.

The writer explains in considerable detail the processes of obtaining the turning effort curve for a reciprocating compressor which is done by integrating the areas under the plus and minus loops of a tangential force curve along lines indicated in connection with Fig. 13. This integration gives the ordinates of the displacement curve which makes it possible with the given flywheel effect in the motor and a given tangential curve, to determine accurately what angular displacement would occur under the assumed conditions; or, conversely, what flywheel effect would be required to limit the angular displacement to a definite value.

Integration of the loops of the crank-effort and velocity curves by planimeter is, however, a very laborious process, and the writer recommends an analytical method which consists in expanding the unbalanced component in the crank-effort diagram, which to proper scale is the acceleration diagram, into a Fourier's series of sines and cosines, and integrating this equation twice for displacement. By proper substitutions the maximum angular displacement may be expressed in electrical degrees.

The author analyzes in considerable degree the electrical phenomena in a synchronous motor as affected by, and affecting, the flywheel effect. This part is not suitable for abstracting. (*A. S. R. E. Journal*, Nov. 1919, vol. 6, no. 3, pp. 159-177, 9 figs., *t*)

METALLURGY (See Heat Treatment; Furnaces)

MILITARY ENGINEERING

Schneider 155-mm. Gun

SCHNEIDER 155-MM. GUN. Description of the Schneider gun of the heavy field-artillery type allowing of firing at a flat trajectory and high-angle fire up to a positive angle of 40 deg.

The original article describes both the 1917 and 1918 patterns. The maximum range exceeds 10 miles with the projectiles weighing close to 95 lb. and having a muzzle velocity of close to 2200 ft. The gun fires from the carriage without any preparation or platform. Three rounds can easily be fired per minute and this rate can be increased to five rounds. The gun is shown in firing position in Fig. 14. It is of steel and consists of a tube, a jacket and a rear block forming an equalizing weight. The breech is closed by an interrupted breech mechanism with plastic obturator operated by hand. Firing is by percussion such that the device does not act until the breech is completely closed.

A table is given showing particulars of this gun. (*Engineering*, vol. 109, no. 2833, April 16, 1920, pp. 512-513, 7 figs., *d*)

MOTOR-CAR ENGINEERING (See Internal-Combustion Engineering)

MUNITIONS (See Military Engineering)

RESEARCH (See Internal-Combustion Engineering)

SPECIAL MACHINERY

Machine for Boring Horizontal Holes in Clay

THRUST BORING IN EARTH. Description of a machine invented by Capt. A. R. Mangnall and made by a British company. It is claimed that this machine will pierce a hole 4 in. in diameter and 150 ft. long horizontally through heavy clay in half an hour. It is intended for cable laying, pipe laying, drainage or similar work. The machine is in a sense an outcome of the war. Several attempts were made to devise an apparatus which could be started from British trenches and bore under those of the enemy holes for mining and countermining. The action of the machine can best be compared with that of thrusting a stick into clay. The machine consists of a hydraulic cylinder of steel tube, carried on trunnions in a light steel frame. Inside the cylinder is a short piston with hinged guiding fingers.

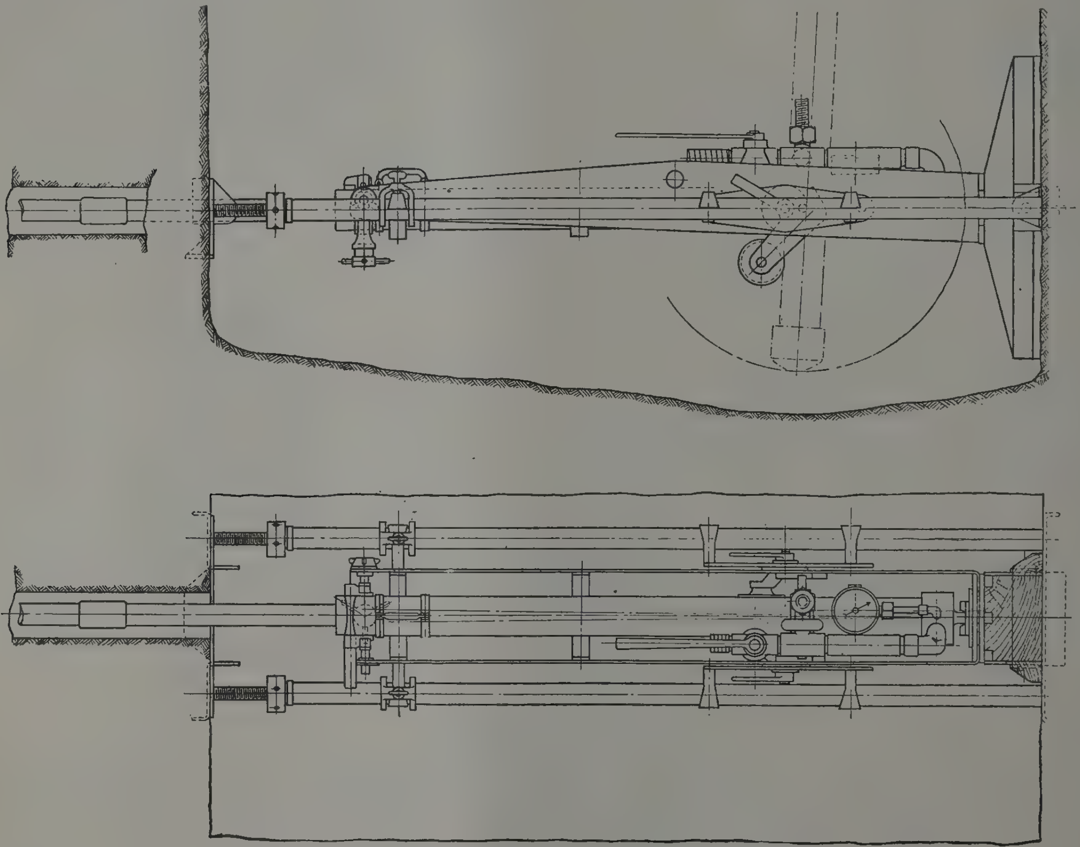


FIG. 15 MANGNALL EARTH THRUST BORER—GENERAL ARRANGEMENT

This "gun" complete on its framework is dropped into a pit dug in the ground to the depth required, a plate at the back of the framework or carriage pressing against a few timbers to distribute the load. The cylinder is connected by flexible pressure pipes to a little three-throw pump driven by a petrol engine. The exhaust water returns to the pump from which the pump draws. The operation of thrust boring is begun by turning the gun up to a vertical position and dropping the "pilot" into it. The gun is then turned down and clamped in position, and hydraulic pressure is admitted behind the piston, pressing the pilot horizontally 4 ft. into the soil. The stroke being completed, the admission valve is closed and the exhaust valve opened—by one and the same lever—the gun is raised to the vertical and the first extension piece pressed into it. The exhaust water is then returned to the sump. The three guide fingers referred to keep the base of the extension piece in a central position. The gun is again placed horizontally, and the extension piece is attached to the end of the pilot by a simple pin joint. The pressure is put on again, and the pilot driven forward another 4 ft. Then the same operation is repeated, extension piece after extension piece being added until the pilot breaks through into a pit at the far end—150 ft. away. The pilot is then uncoupled and lifted out of the pit, and the extension pieces are withdrawn and uncoupled one by one. The whole operation of raising the gun, inserting an extension piece, lowering the gun, fixing the pin joint, and thrusting the piece home occupies something less than one minute.

The joint is extremely simple and ingenious. The extension pieces are tubes about 2½ in. diameter for a 4-in. hole, with muff couplings at the leading end. Through each coupling is drilled a pair of opposite holes; through the other end of each piece is drilled a corresponding pair of holes, but of smaller diameter. The pins are turned to fit the smaller holes freely, but at each end are reduced in diameter so as to leave a shoulder. The operator brings the holes opposite each other, slips the pin in position, and dabs a little bit of clay round the end. It is found that the clay locks the pins effectively and that they never fall out. The withdrawal of the extension pieces is easy, since their diameter is a good deal less than that of the hole. The method generally employed is to attach a rope to the last piece and carry it round a pulley. Two or three men on the surface can then pull the whole chain of extension pieces back until the next joint is reached. The operation is repeated until the operator in the pit can pull the rods back without assistance. An alternative method is to turn the gun up to a vertical position, and by means of suitably arranged ropes and pulleys employ it like the cylinder of an hydraulic crane. (*The Engineer*, vol. 129, no. 3354, April 9, 1920, pp. 369-371 and 376, 7 figs., *dA*)

STEEL MILLS (See Bureau of Standards)

TESTING (See Internal-Combustion Engineering)

TRANSPORTATION

THE STABILITY OF MOTOR OMNIBUSES. In view of the growth of the use of motor omnibuses for city transportation, an editorial in *The Engineer* in reference to the safety of this type of vehicle becomes of considerable interest. It would appear that within the past year there have been a number of cases in England where motor omnibuses overturned and there is a growing suspicion that the motor omnibus is not quite as safe a vehicle of travel as has been assumed hitherto.

Among the causes of this alleged condition are mentioned the carelessness of drivers who learned to take undue risks in France, the bad condition of the roads and the degree of overcrowding now permitted in England in the interior of the omnibuses.

These causes do not appear, however, to be capable of explaining some of the accidents and it would seem as if the real cause lay in the design of the omnibuses. As regards this latter, the motor omnibus used on the London streets is a vehicle weighing in service condition some 9850 lb., of which weight a little over 64 per cent is in the chassis. It is capable of carrying without overcrowding 36 people, representing on an average a load of 5400 lb. so that when fully loaded the vehicle and load weigh something in the neighborhood of 6½ tons.

Its center of gravity in service condition, but without load, lies low down, being only about 44.5 in. above the road surface and just a little above the level of the tops of the rear wheels. The gage of the wheels being 70 in., it follows that the vehicle will recover itself if it is tipped up until the rear axle is lying at 38 deg. to the horizontal. When the omnibus is fully loaded the center of gravity rises to 62 in. above the road surface so that in this condition the maximum heel from which the vehicle will recover itself is 29.5 deg. These figures do not take account of the fact that the body is mounted flexibly on the chassis. In an actual test the yielding of the springs permitted the vehicle to be tipped when empty until the center line of the body was inclined at 46 deg. to the vertical.

It would appear, therefore, that the motor omnibus is quite stable when stationary. When it is in motion the angles of heel mentioned above are a measure of its stability so long as its course is a straight line. The critical test for the stability of the vehicle arises when centrifugal force comes into play during the rounding of a corner. Taking 30 ft. as the radius of the curve and 7 miles per hour as the speed when rounding the corner, it would appear that the stability of the omnibus is reduced by a little over 18 per cent, and if the vehicle carries passengers on the top only the loss of stability is a trifle over 19 per cent. Under these circumstances the critical condition of equality between the upsetting moment and the righting moment will be reached if the heel amounts to 23¼ deg. with the vehicle fully loaded or 22½ deg. if the passengers are entirely on the top. These angles would be reached only if the wheels on the inner side of the curve were lifted off the ground to a height of about 27 in., a condition hardly likely to be encountered, and even this aggregation of unfavorable conditions is counteracted to a certain degree by the fact that the body of the vehicle is mounted on springs.

The stability of the modern motor omnibus may therefore be considered as satisfactory and while the vehicle could be made more stable this is hardly necessary and perhaps not even desirable, as increased stability could be obtained only at the cost of reducing maneuverability and this might lead to an increase of accidents on crowded streets.

It would appear, therefore, that such accidents of overcrowding as have occurred have been due to exceptional conditions present in each individual case.

It might be added in this connection that such accidents as overturning of an omnibus are practically unknown in New York City. (*The Engineer,* vol. 129, no. 3355, April 16, 1920, pp. 401-402, editorial, *g*)

CITRÖEN GEAR FOR ELECTRIC LOCOMOTIVES. Description of the application of Citröen gears for electric locomotives by the Oerlikon Works Company.

This is a result of tests over a period of many years. The locomotive put on the line in 1911 is still in service. It was, however, a comparatively slow-speed type. In 1913 another type was placed in service to run with commercial speeds as high as 70 km. (43.5 m.p.h.) and operate on rather heavy grades at speeds of about 30 m.p.h.

A somewhat strange phenomenon was noticed on that locomotive. Rather heavy vibrations occurred when the speed was between 24.5 and 24.8 m.p.h. and reached their maximum at speeds between 24.8 and 25.4 miles, but disappeared when the speed was between 25.4 and 25.7 m.p.h. The same phenomenon occurred during the slowing down and was maintained so long as the speed remained between 24.5 and 25.7 miles.

At first the trouble was thought to be due to an inaccurate division of the teeth, but had that been the case the oscillation would have increased between the speed of 25.4 and 43.5 miles in proportion to the square of the speed. These vibrations were so serious that they led in some instances to fracture of the coupling rods. It was clear that the vibrations arose through resonance. One of the causes of the resonance could be looked for in the play of the crankpin and coupling-rod bearings. Such a play, when it exists, has in itself an influence which is constant and is independent of the speed; this influence becomes serious only when it is amplified by resonance—that is, when another periodical cause is superimposed upon it. Here, apparently, this second cause has a fixed period which corresponds precisely to the speed of 24.8 to 25.4 miles, but just what its nature is does not appear to be clear yet, notwithstanding much experimental work.

The load is distributed on the axles by means of equalizers, as in the case of steam locomotives. The locomotive complete weighs in running order 108.6 metrical tons; the five central pairs of wheels and axles weighing each 2040 kg., and the two end ones 1530 kg. each, while the suspended load is 95,340 kg. On the other hand, the maximum designed load on a driving axle is 17,000 kg.; on this basis, and reckoning further on, a maximum load of 11,800 kg. for each end axle, the suspended load does not exceed 14,960 kg. for each of the five driving axles and 10,272 kg. for each of the two end axles. But the weight of a complete motor is made up as follows: Rotor, 4,715 kg.; pinion, 449 kg.; shaft, 459 kg.; stator, 6715 kg.; intermediate shaft and toothed wheel, 2410 kg.; crankplates, 400 kg.; making up a total of 15,150 kg. in round numbers. Since half the weight of each of the two motors is taken by the middle axle, as also a part of the weight of the frame plates and body, it is clear that the load over this middle axle must be in excess of that authorized by the regulations, so long as the rigidity of the frame is insufficient to transfer part of this load to the other axles, since the central load is distributed solely by special springs on the corresponding axle, without an equalizer. Consequently, if the conditions under which the frame plates undergo flection be gone into by using the Clapeyron formula, it is necessary to take into account the flection of the frame plate between the axles preceding and following the middle one, otherwise the middle axle would be loaded above the regulation figure.

The frame plate can thus only be considered as a girder resting on six bearings instead of seven, bearings which are on a level, while the central axle bearing exerts an upward force of 14,960 kg. (*Engineering,* vol. 109, no. 2839, May 26, 1920, pp. 712-714, 7 figs., *dt*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Endowment for Engineering Foundation

ENGINEERING FOUNDATION was organized to care for the generous gifts of Mr. Ambrose Swasey, the income from these gifts being devoted to engineering research. Since its organization the funds have been used to aid the National Research Council and others in performing research directly connected to engineering.

Potential benefits for the whole nation are very great, but these benefits cannot be gained without expenditure of effort and materials. Research workers must be supported. Equipment, materials, working places and traveling facilities must be provided. Since the benefits accrue to the profession, the industries and the public in general, support in large measure should come from general funds, such as those provided by endowments.

Although engineers, like other professional men as a class, are not wealthy, some individual engineers have large means. Engineering Foundation seeks to build up its endowment to dimensions worthy of the profession. Engineers connected with industrial and financial organizations having great resources can aid by convincing proper officials of corporations that the continued prosperity of our industries depends upon continued progress of research. Since the commercial and industrial establishments of the country reap the larger proportions of the financial profits arising from scientific and technological work, these establishments should contribute liberally to the support of research.

There are many problems relating to the materials and forces of engineering on which further knowledge is needed. Progress will be made approximately in proportion to the funds made available. But there are other kinds of problems which concern the engineer. No longer may one declare, as did Prof. J. H. Johnson a generation ago, that "Engineering differs from all other learned professions in this, that its learning has to do only with the inanimate world, the world of dead matter and force." Many acute social and economic questions of our day need the dispassionate, impartial, patient study of scientists and technologists. To these questions must now be applied the scientific method of collecting facts by thorough study, and the engineer's capacity for planning and performing, instead of ill-considered "reforms."

Occasionally experimental work is undertaken in accordance with a well-conceived plan as a necessary or desirable adjunct to the main operation. In such cases the exigencies of the main operation sooner or later interrupt the experimental work; or the men who have it in hand leave the force; or the information is gained but never written up; or the statement is buried in some report of limited circulation; or greater familiarity with research methods and a broader conception of the problem could, with small additional expense, have secured much more valuable results and have made them more generally useful.

The services described in the foregoing paragraphs, and many others, could be performed by Engineering Foundation, if adequate funds could be placed at its disposal. The Foundation does not plan to build laboratories and conduct research work directly, but rather to stimulate, coördinate and support research work in existing scientific and industrial laboratories, coöperating, in so far as possible, with the National Research Council.

Mr. Charles F. Rand, of 71 Broadway, New York, Past-President of United Engineering Society, and of the American Institute of Mining and Metallurgical Engineers, was elected Chairman of Engineering Foundation March 19, to succeed Dr. W. F. M. Goss, resigned. With the collaboration of Mr. Swasey, Mr. Rand is actively seeking additions to the endowment which will swell the total to at least a million dollars in the near future. Mr. Swasey's gifts amount to $300,000.

The office of Engineering Foundation is in the Engineering Societies Building, 29 West 39th St., New York. Further information may be had by addressing this office or the chairman. A booklet giving an account of the Engineering Foundation and its work will be mailed upon request.

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Cement and Other Building Materials A4-20 The Use of Wet and Dry Sand for Concrete. Concretes made from Potomac sand and gravel in various proportions from 1:1½:3 to 1:3:6 with various extremes of flowability have shown that when the aggregates are proportioned by volume measure it is found that wet aggregate requires from ½ to 1 bag of cement per cu. yd. more than concrete with dry aggregate. Sand is generally wet or at least moist when used so that the full difference may never be apparent in field practice, yet the use of sand from a pile which has just been wet from the rain will result in the employment of more cement for a given volume of concrete than would have been the case had the work been done on a dry day. Marked improvement in the working qualities of concrete will be noted under the usual conditions when the relative volume of sand is increased and the gravel proportionately reduced. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Heat A2-20 The Efficiency of Insulation Used in Cold-Storage Work. The Bureau of Standards has conducted a number of experiments on the coefficient of conduction through insulating materials. This has been done by the flat-plate method, in which the coefficient of conduction rather than the coefficient of transmission has been determined. Preliminary results have been transmitted to the June Meeting of the American Society of Refrigerating Engineers and issued by them in their Journal and also issued by the Bureau of Standards as a scientific paper. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Leather and Glue A1-20 Service Tests on Chrome-Tanned and Oak-Tanned Sole Leather. Twenty-five service tests have shown that chrome leather outwore oak leather by about 23 per cent per unit thickness. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A11-20 Heat Treatment of High-Chromium Steel. Experimental work on samples of high-chromium steel containing C 0.29 per cent, Mn 0.38 per cent, Si 0.70 per cent, and Cr 13.2 per cent has been completed and a report submitted to the Journal of the American Society of Automotive Engineers. The samples were heated to various temperatures and quenched in oil. The following results are shown:

a Hardness by Brinell and Shore instruments increases with the temperature until 1950 deg. fahr. is reached. Maximum range of hardness is generally obtained by quenching from this temperature up to the highest heat used, but in some cases this hardness actually decreases due to the retention of the solid solution.

b Quenching from about 1750 deg. fahr. develops the best combination of strength and ductility which is not coincident with maximum hardness. Quenching from this or a lower temperature does not retain all the carbide in the solution, as is the case in samples quenched from considerably higher temperatures, notably 2100 deg. fahr. and 2250 deg. fahr.

c Ductility as measured by elongation and reduction is very low when quenching occurs from 1850 deg. fahr. or above.

d Short-time tempering at temperatures above 800 deg. fahr. decreases brittleness. Ductility is increased to a greater extent in sample quenched from 1750 deg. than those at higher temperatures. Tempering above 800 deg. fahr. decreases the strength and hardness in a marked manner, although ductility is increased. Address S. W. Stratton, Bureau of Standards, Washington, D. C.

Properties of Engineering Materials A8-20 Strength of Steel. The relation between the elastic strengths of steel in tension, compression and shear is the subject of Bulletin No. 115, Engineering Experiment Station of the University of Illinois, by Prof. F. B. Seely and W. J. Putnam. The Bulletin presents the results of experiments on soft, mild and medium carbon steels and vanadium, nickel and chrome-nickel steels. The elastic strengths in tension, compression and shear are given for each of the six grades. The shearing strength in torsion was found from solid cylindrical specimens and thin-walled hollow specimens. The main object of the investigation was to determine carefully the elastic shearing strength of ductile and semi-ductile and find the ratio of the elastic shearing strength to the elastic tensile strength.

Ductile rods or specimens from rolled shapes when tested in tension showed a sudden or abrupt elastic breakdown. The elastic shearing failure of solid cylinders is also abrupt with well-defined yield point. This seems to indicate that tensile failure is really a shear failure. The hollow thin-walled specimens do not show such an abrupt elastic failure in shear, and therefore the shearing breakdown is more gradual than the corresponding tensile breakdown. The following abridged conclusions are made at the end of the Bulletin:

1 The correct value of the elastic shearing strength and yield point in shear of steel as measured by the proportional limit or the useful limit point may be determined from a torsion test of a hollow thin-walled cylindrical specimen.

2 The correct value of the elastic shearing strength of steel as measured by the proportional limit or the useful limit point may be taken, with reasonable accuracy, as eighty-five hundredths (0.85) of the elastic strength obtained from a torsion test of a solid cylindrical specimen. The correct value of the yield point for the more ductile materials is slightly more than eighty-five hundredths (0.85) of the yield point obtained from a test of a solid torsion specimen.

3 A solid cylindrical torsion specimen may be used to obtain test results. The character or progress of the breakdown of the elastic action may be obscured in the test of the solid specimen. Test results obtained from a solid specimen may also be used to judge of the general properties, quality and reliability, of the materials.

4 The correct value of the elastic shearing strength of steel as measured by the proportional limit or the useful limit point is from fifty-five to sixty-five hundredths (0.55 to 0.65) of the elastic tensile strength and may be taken with reasonable accuracy as six-tenths (0.6) of the elastic tensile strength. The maximum shear theory of the failure of elastic action of ductile steel (sometimes called Guest's Law) is, therefore, not an accurate statement of the law of elastic breakdown, since Guest's Law assumes that the elastic shearing strength is one-half (0.5) of the elastic tensile strength. The maximum-shear theory as expressed by Guest's Law, however, is of much use in obtaining approximate results.

5 Contrary to the general belief, the breakdown of the shearing elastic action of ductile and semi-ductile steel as found in these tests is gradual; more gradual, as a rule, than the failure of elastic action in a tension specimen.

6 The amount of hot-rolling received by steel may have a marked effect upon the relation of the elastic tensile and compressive strengths. For the material from ¾-in. and ⅞-in. bars, the elastic compressive strength is somewhat greater (about 5 per cent) than the elastic tensile strength, whether the elastic strength is measured by the proportional limit, useful limit point or the yield point. For the material from the 3½-in. bars, the compressive proportional limit is very much greater (27 per cent) than the tensile proportional limit, while the compressive yield point is somewhat less (4 per cent) than the tensile yield point.

7 It appears, therefore, that the choice of the criterion of elastic strength may be of considerable importance in some cases, and that the usual tensile test of material may require supplementary compressive tests or a better correlation between test data and the amount of treatment received during rolling before the elastic properties of the material as obtained from tensile test data can be relied upon.

8 The elastic strength and ultimate strength of steel in tension, in compression, and in shear is affected little, if any, by the direction of rolling in the case of a slab 2 in. thick, although the ductility, as measured in tension tests by the percentage of elongation and percentage of reduction of area, is materially less when the stress is perpendicular to the direction of rolling than it is when the stress is parallel to the direction of rolling.

University of Illinois, Engineering Experiment Station, Urbana, Ill. Address C. R. Richards, Director.

Properties of Engineering Materials A9-20 Magnetic Uniformity of Steel. The Bureau of Standards has recently tested 54 bars 1 in. in diameter, 12 ft. long for magnetic uniformity. The bars were intended for experiments on heat treatment of carbon steel. The determination was made by passing the test specimen at a uniform rate through a magnetizing solenoid energized by direct current and noting the deflection on a sensitive instrument connected to a system of test coils located within the magnetizing solenoid. With uniform material no deflection occurs while variations in uniformity gave deflections of which a photographic record was made. Five bars were found to give relatively large deflections at certain points. Regions thus located were cut out and not used in the investigation. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Welding A1-20 Electric Arc Welding. In an investigation about to be published by the Bureau of Standards it has been discovered that fusion welds differ from all other types in that the metal of the weld is essentially a casting. No refinement of this metal is possible in the method as ordinarily carried out. The characteristic properties of the arc-fused metal have been determined in this study. The work shows that skill, care and patience on the part of the operator is a matter of vital importance. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Automotive Vehicles and Equipment B2-20 Dynamics of Load Suspension on a Motor Vehicle. A study of the forces involved in the action of tires, axles, springs and body of truck when passing over obstructions in the path of the wheels. An analysis of curves obtained by driving a truck at constant speed across the field of a camera in the dark, lights on the body and axles tracing the motion of those parts on the camera plate. This includes the determination of the force of impact on the obstruction and the pavement beyond the obstruction. Address Asst. Prof. W. E. Lay, Charge of Automobile Engineering, University of Michigan, Ann Arbor, Mich.

Automotive Vehicles and Equipment B3-20 Fuel Economy of a Motor Vehicle. Much has been said about the apparent improvement in operation of the automobile engine on a summer evening. Preliminary tests have indicated the possibility of a daily cycle in the variation of fuel-mileage economy. The attempt is being made by means of a series of 24-hour runs to determine upon which variable or combination of variable conditions the change in fuel mileage depends. Address Asst. Prof. W. E. Lay, Charge of Automobile Engineering, University of Michigan, Ann Arbor, Mich.

Cement and Other Building Materials B2-20 Building Columns Under Fire. The Underwriters' Laboratory of Chicago is working on a report of a test of 105 columns under fire. These columns have been loaded to capacity and in this condition were subjected to the standard fire temperatures. The work is being done in coöperation with the Bureau of Standards, National Board of Fire Underwriters and the Associated Factory Mutual Fire Insurance Companies. It has been in progress for three years and the report will soon be made. Address Underwriters Laboratories, 207 E. Ohio St., Chicago, Ill.

Fuels, Gas, Tar and Coke B1-20 Carburetion of Fuels. See *Internal-Combustion Motors B7-20.*

Heating B2-20 Sample House in Saskatchewan. Seven different types of house built as 6-ft. cubes of different types of building construction have been erected at the college at Saskatoon, Sask. The temperature in this locality reaches 50 deg. below zero with no wind and 15 to 20 deg. below zero with a strong wind. Recording thermometers of the Leeds and Northrup type are being used. The amount of heat to warm these houses is being determined. Address Prof. A. R. Greig, Saskatoon, Sask.

Heating B3-20 Direct-Indirect Systems. The Mechanical Engineering Department of the Iowa State College has been making tests on direct-indirect systems of heating. Address Prof. M. P. Cleghorn, Iowa State College, Ames, Ia.

Heating B4-20 Loss of Heat from Underground Mains. The Mechanical Engineering Laboratory of the University of Michigan is coöperating with the Ric-wil Company of Cleveland, Ohio, and the Research Bureau of the American Society of Heating and Ventilating Engineers in attempting to secure data from experiments upon a bare pipe buried in the ground whereby the paths of heat flow can be traced. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Heating B5-20 Velocities in Hot-Water Heating Systems. The Mechanical Engineering Department of the University of Michigan is conducting some experiments to determine the velocity of water when the radiator is located upon the first, second and third floor above the heater when natural circulation of the water is employed. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Metallurgy and Metallography B7-20 Tensile Properties of Boiler Plates. Boiler plate rolled at a blue heat (300 deg. cent.) has been used to determine the properties at elevated temperatures and the effect of blue work. The effect of low-temperature annealing is to be determined. Special apparatus has been constructed to determine the effect of the rate of loading on the elastic limit at elevated temperatures, using a motion-picture camera. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Delaware College D1-20 The small laboratory at Delaware College is equipped with two single-expansion engines, a condenser, a small air compressor, a 30,000-lb. testing machine, a hydraulic ram, two gas engines, and a centrifugal pump. Address Merrill V. G. Smith, Delaware College, Newark, Del.

General Bakelite Company D1-20 The Physical Laboratory of the General Bakelite Company at Perth Amboy, N. J., contains the following apparatus for use in their research work:

One 100,000-volt, 60-cycle testing transformer with facilities for making tests on standard A. S. T. M. molded samples in air and oil at full voltage.

One 30,000-lb. Olsen Universal testing machine.

Insulating resistance outfit with direct current at 15,000 volts with galvanometer of sensitivity of 5×10^{-10} for resistance of five million megohms.

Olsen heat-distortion testing machine for molded insulation materials according to A. S. T. M. standards.

Special apparatus for determining plastic quality.

Auxiliary apparatus for standard laboratory work.

Address Gilbert L. Peak, Electrical Engineer, General Bakelite Company, Perth Amboy, N. J.

E—PERSONAL NOTES

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Electrochemistry F2-20 Electric Furnaces. The electric furnace as applied to metallurgy. A reading list from 1900 to 1919 by Clarence J. West, a paper presented to the American Electrochemical Society at Boston, April 8 to 10, 1920. See Vol. 37 of the Transactions of the American Electrochemical Society. A bibliography of 92 pages of general articles on electrodes, iron, steel alloys, ferrosilicon, ferromanganese, ferrochromium, ferrotungsten, ferromolybdenum, non-ferrous metals, brass, copper, nickel, tin and miscellaneous metals. Address Arthur D. Little, Inc., Cambridge, Mass.

Fuels, Gas, Tar and Coke F4-20 Fuel-Oil Use in Locomotives. A bibliography of one page. Address A.S.M.E., 29 West 39th St., New York.

Cleveland Engineers Hold Joint Meeting

Cleveland Engineering Society Celebrates Its Fortieth Anniversary with Engineers' Club of Dayton, A.S.M.E. and Other Local Sections Coöperating

The fortieth annual meeting of the Cleveland Engineering Society was held on June 8 with an attendance of nearly four hundred. A delegation of seventy-eight members of the Engineers' Club of Dayton was present and contributed to the success of the meeting. The Cleveland A. S. M. E. Section had charge of the arrangements for the several trips of inspection which were made during the day, which included visits to a number of the leading industrial plants of the city.

During the morning while registration was progressing, motion pictures were shown at the rooms of the Cleveland Engineering Society on the fourteenth floor of the Hotel Statler. These illustrated operations in the plant of the Cleveland Automatic Machine Co., with talks by E. E. Blundell on the Cleveland Automatic Turret Machines and by H. T. Simmons, of the Wellman-Seaver-Morgan Co., on An Improved Car Dumper.

The Cleveland University Club was the scene of a banquet in the evening, at which inspiring addresses were given by Col. Edward A. Deeds, of Dayton, Ohio, and Dr. E. J. Cattell, of Philadelphia, Pa. Colonel Deeds spoke on The Benefits of Engineering Associations and he pointed out the many opportunities awaiting the engineering profession through coördinated action on the part of the local and national engineering societies. He stated that he was thoroughly convinced that an analysis of the reasons for the remarkable development of many of our large industrial cities, such as Cleveland, would undoubtedly show that the local engineering organizations had played a very important part in the growth of such places. He emphasized the fact that such a city as Dayton, with no seaport facilities, was largely dependent upon the industrial activity of the community for its progress, and through the establishment of a strong local engineering organization like the Engineers' Club of Dayton, provision was made for fostering the research and experimental work so essential for the continued growth and prosperity of the city. In closing he extended a hearty and most cordial invitation to the engineers of Cleveland to visit Dayton next year, because he believed that the exchange of ideas and the mingling of engineers of one locality with those of another advance the profession to a much greater extent than is appreciated.

Honorary membership in the Cleveland Engineering Society was conferred upon Dr. Dayton C. Miller, of the Case School of Applied Science, for his achievements in developing instruments for measuring the distance and direction of sound, and whose research work in sound waves and their photography has been notable. The other honorary members include such notable engineers and scientists as Charles H. Benjamin, Charles F. Brush, Gustav Lindenthal, Albert A. Michaelson, E. W. Morley, W. H. Searles, Ambrose Swasey, and Worcester R. Warner.

Mr. Edwin S. Carman, retiring president of the Cleveland Engineering Society, gave a brief outline of the work accomplished by the organization during his term of office and emphasized especially the degree to which it has succeeded in bringing about coöperation with the local sections of the various national engineering organizations and other local engineering groups. All such activities in Cleveland are now concentrated in the rooms of the Cleveland Engineering Society. The new president, Mr. William J. Carter, a consulting civil engineer, assured the organization of his best service and promised to do everything to develop the activities of the society along public service lines and in the leadership in such matters as suitable legislation in the state of Ohio as to the licensing of engineers. The Cleveland Engineering Society has long taken an active interest in municipal engineering matters, and the community has come to look to it for guidance in this direction. Col. Elliott H. Whitlock made an excellent toastmaster and the general atmosphere of the meeting was such as to justify the statement that it "was the best ever."—E. H.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 253, 268, 275, 278, 283, 287, 288, 291-298 inclusive, as formulated at the meeting of April 22, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 253 (Previously annulled)

Inquiry: Is it permissible under the requirements of the Boiler Code to use for boiler construction, tubes or flues that have been formed into the desired lengths by welding together at their ends, short lengths of such tubing by the electric pressure welding process, provided the metal upset at the weld is immediately rolled down to the proper thickness while under the heat of the weld?

Reply: It is the opinion of the Committee that while there is no objection to the safe-ending of tubes for fire-tube boilers by a suitable forge or pressure welding process, the suggested method of making the tube from a number of short pieces would be an objectionable practice. The Committee does not consider the practice of safe-ending of tubes to be a suitable one for water tube boilers.

CASE NO. 268 (Reopened)

Inquiry: *a* Inasmuch as the discharge of feedwater into vertical fire-tube boilers in accordance with the requirement of Par. 316 of the Boiler Code has caused serious difficulties from leaky tubes in the lower tube sheet, a reconsideration is requested of Case No. 145, in which the opinion of the Boiler Code Committee is given that the discharge of feedwater in the water leg of a vertical fire-tube boiler is not permissible.

b In case it is ruled that such discharge of feedwater into the water leg of a vertical fire-tube boiler is not allowed, is it permissible to protect the feedwater discharge through a feedwater pocket riveted within the shell at a point above the water leg, with handhole opening for cleaning?

Reply: *a* It is the opinion of the Committee that Par. 316 does not permit of discharging the feedwater in the water leg of a vertical fire-tube boiler, and that difficulties with leaky tubes may be avoided by the use of an internal feed pipe which does not discharge into the water leg.

b It is the opinion of the Committee that such a method of delivery of feedwater to a vertical tubular boiler through an internal pocket or baffle above the water leg, with handhole opening for cleaning, is in full accordance with the requirements of the Boiler Code.

CASE NO. 275

Inquiry: Is autogenous welding permissible for the longitudinal joint of the fire box of a form of vertical boiler as shown in Fig. 3, where the furnace section is, after welding, heated and corrugated by rolls? The corrugations are rolled to a depth of 1½ in. on 8 in. centers, and the weld shows no fracture or distress after either corrugating or flanging.

Reply: It is the opinion of the Committee that the construction referred to fully complies with the requirement of Par. 186 of the Boiler Code, and the thickness of the furnace for a given maximum allowable working pressure should be determined in accordance with Par. 243.

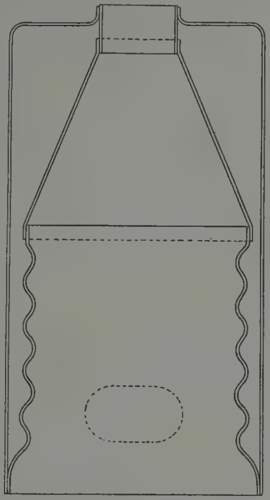


FIG. 3 VERTICAL SINGLE-FLUE BOILER WITH CORRUGATED FIRE BOX

CASE NO. 278

Inquiry: What would be considered the lowest permissible water level for a vertical water-tube boiler of the type shown in Fig. 4? Par. 430*v* of the Boiler Code to which reference is made in Par. 291 relative to the lowest permissible water level, leaves the location rather problematical as there may be a difference in opinion as to what the lowest permissible water level may be.

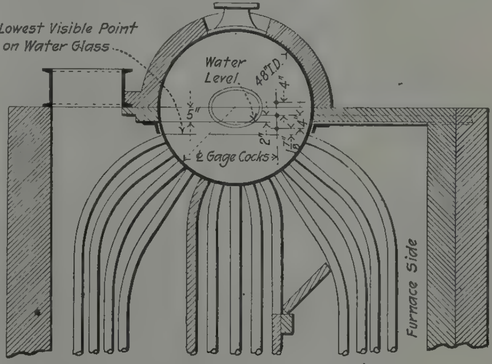


FIG. 4 LOCATION OF THE LOWEST PERMISSIBLE WATER LEVEL

Reply: It is the opinion of the Committee that for a water-tube boiler of the design illustrated, a location for the lowest permissible water level such as referred to in Par. 430 *i* would be a suitable and safe construction.

CASE NO. 283.

Inquiry: In the construction of a water-tube boiler in which the tubes enter the tube sheet at an angle as great as 20 deg. from the normal, may the requirements of Par. 252 of the Boiler Code be fulfilled if the least projection of the tube be not less than ¼ in., or more than ½ in.?

Reply: It is the opinion of the Committee that Par. 252 applies to tubes which enter normally to the sheet and that where the tubes are at an angle, the least projection of the tube should be not less than ¼ in. or more than ½ in., which may result in the tube projecting more than ½ in. at other points around the tube. The rule given in Par. 251 for flaring should apply to the true diameter of the tube hole measured in a plane at right angles to the tube end and not to the maximum diameter of the elliptical opening in the tube sheet.

CASE NO. 287

Inquiry: Is it permissible to burn off the edges of boiler plates and use them without any finish where sheared edges would be permitted by the rules in the Boiler Code?

Reply: The Code does not prohibit the practice suggested.

CASE NO. 288

Inquiry: Where a manhole is applied to the head of a dome and an opening for access to the boiler is placed in the shell under the dome, is it necessary to reinforce this opening in accordance with the requirements of Par. 260?

Reply: It is the opinion of the Committee that such an opening should be reinforced in accordance with the requirements of Par. 260. The reinforcing effect of the base of the dome may be included in calculating the reinforcement.

CASE NO. 291

Inquiry: In the case of a special arrangement of spacing of tube holes in the shells of the drums of a water-tube boiler with the pitch unequal in every second row, but shifting the adjoining rows to an exact stagger as shown in Fig. 6, is it proper to calculate the efficiencies of ligaments under the requirements of Pars. 192 or 193 of the Boiler Code?

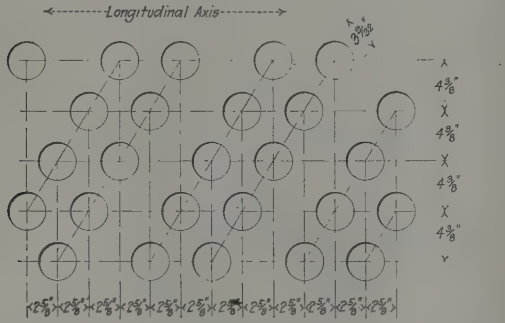

Longitudinal Axis
$3\frac{3}{32}$"
$4\frac{3}{8}$"
$4\frac{3}{8}$"
$4\frac{3}{8}$"
$4\frac{3}{8}$"
$2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$" $2\frac{5}{8}$"

FIG. 6 SPECIAL SPACING OF TUBE HOLES IN DRUM OF WATER-TUBE BOILER

Reply: It is the opinion of the Committee that the efficiency of the tube sheet should be obtained by employing the method outlined in Pars. 192 and 193 of the Code for diagonal ligaments. All possible methods of failure should be assumed and the lowest value obtained through any one of the methods, should be used.

CASE NO. 292

Inquiry: In the case of a triple-riveted butt and double strap joint with the pitch of rivets in the first and third rows one-half of that of the second row, as shown in Fig. 7, what is the proper method of determining the back pitch between the first or inner and second or middle rows of rivet holes?

Reply: It is the opinion of the Committee that the back pitch required between the first or inner and the second or middle rows of rivet holes in such a design of joint, shall be governed by the rules of Par. 182 for determining the back pitch between the second and third or outer rows of rivets.

CASE NO. 293 (In the hands of the Committee)

CASE NO. 294

Inquiry: Is it the intent of Par. 331 of the Boiler Code that at least one complete set of the four stamps specified for boiler plate in Par. 36 remain visible after the completion of the boiler, or if the slab or melt number is invisible, are the remaining markings sufficient to meet the Code requirements?

Reply: It is the opinion of the Committee that all of the information which the Code requires to be stamped on the plates at the mills must be obtainable from the finished drum structure for each plate. All four stamps need not be visible at a given point if the fragments from various sets can be pieced together so as to give the desired information.

CASE NO. 295

Inquiry: How may an inspector in the field know the range of tensile strength of boiler plate?

Reply: Attention is called to the fact that the range for all classes of steel specified in the Code is 10,000 lb. per sq. in. and the tensile strength stamped on the plate indicates the minimum of this range, which minimum under the rules must not exceed 55,000 lb. per sq. in.

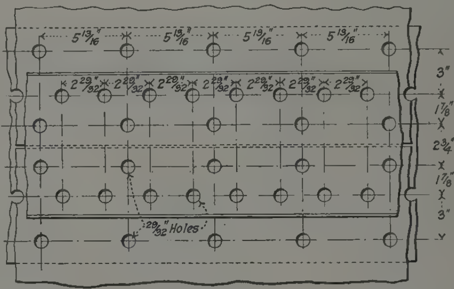


FIG. 7 TRIPLE-RIVETED JOINT WITH WIDE RIVET SPACING IN INNER ROWS

CASE NO. 296

Inquiry: Will a water-tube boiler of a type largely used in marine service, the heating surface of which is constructed mainly of iron pipe screwed into malleable iron and steel fittings, meet the requirements of the Boiler Code, if the pipe used is a special quality of redrawn lap-welded iron pipe of puddled stock and tested to 1000 lb. hydraulic pressure?

Reply: There is nothing in the Boiler Code to cover the use of iron pipes for the tubes of such a boiler with screwed joints. Until such a time that the specifications for piping have been formulated, the Boiler Code Committee would consider that if the other requirements of the Boiler Code are met, special redrawn pipe not to exceed 1½ in. standard pipe size made from lap-welded iron of puddled stock and tested to 1000 lb. hydraulic pressure, may be used for a working pressure not to exceed 200 lb. per sq. in., provided the wall thickness is at least 50 per cent greater than the wall thickness required by the Code for tubes of water-tube boilers.

CASE NO. 297

Inquiry: Will the requirements in the Boiler Code for automatic water gages be met under the terms of Par. 427*e*, if the shut-off valve in the upper fitting has a projection which pushes the ball away from the seat for a distance of ⅛ in., causing the ball to drop to a position considerably greater than ¼ in. away from its seat?

Reply: It is the opinion of the Committee that the intent of the requirements of the Code will be met in the construction described.

CASE NO. 298

Inquiry: Is it permissible in the case of a forged steel steam outlet riveted to the boiler shell to use a wrought steel flange screwed to the outer end of the endneck, the neck being properly threaded and peened over into a beveled part cut away from the flange?

Reply: It is the opinion of the Committee that this method of forming a steam outlet connection meets the requirements of the Rules in the Boiler Code.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Simplification of Venturi-Meter Calculations

TO THE EDITOR:

In regard to my article on the above subject in the April issue of MECHANICAL ENGINEERING and Mr. C. G. Richardson's comments in the May issue, I wish to state the following:

Mr. Richardson is probably entirely right in his statement regarding the drop which should take place across a well-designed and constructed venturi meter. As I was not interested particularly in this drop at the time of making the experiments referred to, I took no pains to measure it accurately and the 2½ in. drop mentioned was not intended to be more than an approximation.

Mr. Richardson's statement as to the permissible ratio between the pressure at the throat and the initial pressure being as low as 0.84 is of course correct, but I would not advise designing a venturi meter having such a ratio of pressure at its rated capacity, inasmuch as any flow in excess of such rated capacity would increase this ratio to such an extent that it would probably go beyond the range of the pressure-measuring apparatus used in conjunction with the meter, whereas if a meter is designed for its rated capacity with the ratio nearer 0.90, it will be possible at times to exceed this flow without increasing the pressure differences very greatly out of proportion to the increase of the flow.

The tabular values of the function of P_2 and P_1 were plotted out to a very large scale for use during the experimental work and are shown in my article only to a reduced scale.

GLENN B. WARREN.

Schenectady, N. Y.

Industrial Training in China

TO THE EDITOR:

The letter appearing on page 305 of MECHANICAL ENGINEERING for May 1920, entitled Industrial Training in China, is of great interest to me, not only on account of my three years as a university professor in China, but because I am generally interested in relations between China and the United States. Mr. Foster has a distinct end in mind, namely, the encouraging of American manufacturers to supply mechanical equipment for schools in China, but in the course of making his argument, quite inadvertently no doubt, he presents a somewhat inaccurate picture of the present status of technical education in China. I am very sure the general reader of his letter will get the impression that there are no technical schools in China worth mentioning, except Peking University. The name of the latter is incorrectly given, by the way, Peking University being a Methodist school which, so far as I know, has never given any engineering courses. The writer doubtless has in mind the Peking Union University, which is just being organized and therefore has its record to make as far as technical education is concerned. On the other hand, there have existed in China for a number of years technical schools that of course have their drawbacks but which on the whole compare very favorably with the state colleges of the less populous states of the West. As to the character of work done, to cite a specific instance, the graduates of Pei Yang University in engineering have in the past found no difficulty in entering American universities of the first class as graduate students and taking their master's degree in one year and their doctor's degree in two years.

I am glad to be able to say that in the majority of cases the instructors in these schools have been Americans and that in nearly all instances they are of a grade that will compare favorably with those in American colleges.

The present situation in regard to the tendency of Chinese students to go to France rather than the United States is even more serious than Mr. Foster indicates in his letter, and it is highly desirable that an effort should be made to promote both the coming of Chinese students to the United States for study and the study of engineering in China.

T. T. READ.

Washington, D. C.

Technical Library Book and Journal Indexing

TO THE EDITOR:

I have just read an abstract of a report made by Mr. Harrison W. Craver, Director of the U. E. S. Library Board.

As one who is much interested in the entire subject and more distinctly so in certain phases, I am pleased to be at one with Mr. Craver in his advocacy of the Dewey Classification and its later extension, the Brussels Classification, and for the same reasons that Mr. Craver has so well expressed.

Mr. Craver states that "the catalog cannot be expected to act as an index to all the books in the library." Undoubtedly this is correct as applied to the present books with their present indexes, but I hope that the time will arrive when all books and all technical journals will be indexed by the same method that is suggested for the books in the library. When that time arrives the book or journal indexes will be logical extensions in detail of the general library index. Nor is this by any sense a utopian dream. The Dewey or Brussels Index is, in actual practice, so simple that it would require probably less time than the preparation of the usual indexing method employed.

Before I advocated this to the publishers of certain technical journals I tried it out myself and made up an extensive index covering the automotive industry in detail. This and the existing Dewey Index applying to mechanical subjects I applied to a year's issue of certain automobile publications and to a year's issue of the *American Machinist*. I found that the entire work occupied less than one-half hour's time daily for a week. Surely an index of this character will be far more useful than the usual haphazard one now found in technical journals under names or titles that have frequently no relationship whatever to the subject itself. The situation is not quite as bad in most technical books, but it is bad enough.

Those engineers who realize that much useful information is to be found in the technical journals which rarely or very late finds its way into books, and who therefore collect such data, would find their task enormously facilitated by the adoption of this indexing method. This work would be further facilitated if they would secure duplicate copies of the journals that they find most useful, in that they could then gather all of the information contained under any given index number in a group and so file it without the necessity of destroying part of any article that might happen to be closely printed with another article under another index number.

The adoption of this plan would also make technical journals much more useful in a library such as the United Engineering Societies Library, in that the index of each journal would be a logical continuation of the Library's index.

It is to be hoped that Mr. Craver will use his and the United Engineering Library's undoubtedly very great influence with publishers and editors to adopt this plan in their own interest as well as the interest of the Library and that of the users of books and journals.

Philadelphia, Pa.

HENRY HESS.

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Those of us who dwell in the past must have memories, enjoyable and fine. With generous, engineering comradery and unbounded St. Louis hospitality we may build a memory of the 1920 Spring Meeting of the A.S.M.E. that will long stand.

The short elapsed time does not allow us to record the parts of the meeting that years from now will remain in mind; but so successful was the well-planned and carefully-executed program of the St. Louis meeting in its appeal to both old-timer and novice that material for memory building abounds.

As suggestions, think of any of the interesting plants visited, recall the beautiful Shaw's garden, the picturesque open-air theater, the jolly ride up the river, or the quiet talk of experience and mutual confidence with an old friend and the making of several new friends. Whatever the individual reason, St. Louis will always be remembered as the place of a wonderfully successful Spring Meeting.

The Federated American Engineering Societies

The outstanding event of the past month has been the conference in Washington of the representatives of about seventy-five (75) of the leading national, regional and local engineering and allied technical organizations.

This conference was the culmination of the work of several committees in the local and national societies during the past few years, resulting in a joint conference committee of the four national engineering societies of Civil, Mining and Metallurgical, Mechanical, and Electrical Engineers.

To say that the conference was a complete success does not begin to describe it; the get-together movement of the professional men in engineering, architecture, chemistry and allied professions is an accomplished fact.

Interest was keen from the minute the conference opened until it closed with inspiring addresses from such men as Homer L. Ferguson, Past-President of the United States Chamber of Commerce; Robert S. Woodward, President of the Carnegie Institution; and James R. Angell, Chairman of the National Research Council.

The reason for the success was the sincere desire of all the delegates to subordinate personal interest, even of the organizations which they represented, to the common good. And the cause of the common good was expressed more fully and perfectly than I have ever yet heard it expressed: *"Service to others is the expression of the highest motive to which men can respond and duty to contribute to the public welfare demands the best efforts that men can put forth. Therefore, it shall be the object of this organization to further the interests of the public through the use of technical knowledge and engineering experience, and to consider and act upon matters common to the engineering and allied technical professions."*

In the long run, success not only of individuals but of organizations is dependent upon the fundamental motive's being unselfish. This is not inconsistent with the greatest possible personal rewards, both to individuals and to groups, which are the natural result of the indispensable services rendered. In other words, the man who can produce the greatest results is the man who can command a high salary. When engaging a man absolutely indispensable to the success of any given enterprise, one of the commonest inducements is that "salary is no object."

With the splendid spirit which actuated the entire conference, the Joint Conference Committee was invited by the delegates to arrange for a fall meeting to complete the organization, the constitution and by-laws having been adopted. In the meantime, until the perfection of the new organization, the Engineering Council was invited to continue to conduct the work which it has started and to take up any other matters which should be acted upon by the Federated American Engineering Societies when that body shall be organized.

With good generalship, the members of Engineering Council (of which there were a goodly number present, in their capacity as members or representatives of some of the societies) secured from their body a formal invitation to all of the organizations represented at the Washington Conference to attend by delegate the next meeting of Engineering Council, on which occasion such delegates would be accorded the privileges of the floor and participation in all debate.

One of the officers of one of the leading foundations is obligated among his duties to investigate and report on all organizations conducted under national, state or municipal auspices. And I firmly believe that if this officer were to investigate in the same manner the Federated American Engineering Societies and reflect on its objects he could report that it is destined to be one of the most useful of organizations—that everyone working with it, whether by serving on its committees or otherwise, will be inspired to give his best to the nation and to the community in which he lives and thus enhance the standing of his profession.

Calvin W. Rice,
Secretary.

Plain Limit Gages for General Engineering Work

The new Sectional Committee of The American Society of Mechanical Engineers recently organized to undertake the standardization of plain limit gages held its organization meeting in the rooms of the Society on Friday, June 11. The Committee met as a whole in the morning and divided into sub-committees for the afternoon session. As a result it has already mapped out its work for the next three months.

This Committee, as will be recalled, was organized by the Society at the request of the American Engineering Standards Committee, and it is planning to coöperate with a similar committee recently organized by the British Engineering Standards Association. The personnel of the Committee is as follows:

E. C. Peck, *Chairman*, Gen. Supt., Cleveland Twist Drill Co., Cleveland, Ohio.
L. D. Burlingame, *Vice-Chairman*, Industrial Supt., Brown & Sharpe Mfg. Co., Providence, R. I.
H. W. Bearce, *Secretary*, Gage Dept., Bureau of Standards, Secy. National Screw Thread Commission, Washington, D. C.
P. W. Abbott, Lincoln Motor Company, Detroit, Mich.
John Bath, President, John Bath & Co., Inc., 8 Grafton St., Worcester, Mass.

- Earle Buckingham, Engineer of Standards, Pratt & Whitney Company, Hartford, Conn.
- Fred H. Colvin, Assoc. Editor, *American Machinist*, 10th Ave. & 36th St., New York City.
- W. A. Gabriel, Ch. Draftsman and Designer, Elgin National Watch Co., Elgin, Ill.
- F. O. Hoagland, Vice-Pres. & Works Mgr., The Bilton Machine Tool Co., Bridgeport, Conn.
- Edward H. Ingram, Works Manager, The Cleveland Milling Machine Company, Box 350, Cleveland, Ohio.
- J. O. Johnson, Major attached to office of Chief of Ordnance, War Department, Washington, D. C.
- A. W. Schoof, Gage Engineer, Greenfield Tap & Die Corporation, Greenfield, Mass.
- G. T. Trundle, Consulting Engineer, Engineers' Building, Cleveland, Ohio.
- H. L. Van Keuren, The Van Keuren Company, 362 Cambridge Street, Boston, Mass.

Swiss Mission to Study American Economic Conditions

The group of Swiss engineers, architects, manufacturers, merchants, and agriculturists known as the Swiss Economic Mission, arrived in New York on May 27. The fact that this organization intended to visit this country to study economic conditions here was made known to the Society last autumn by the Hon. Hans Sulzer, of the Swiss Legation of Washington, D. C. The members, although not official representatives of the Swiss government, are progressive professional men of eminence.

The fact that Switzerland feels its indebtedness to this country for its supply of foodstuffs, especially cereals, during the war, was expressed by Professor Hilgard, of Zurich, at a dinner given to the entertainment committees of the American Society of Civil Engineers and The American Society of Mechanical Engineers at the Hotel Pennsylvania, June 3.

The party has been conducted on a general sight-seeing tour throughout the eastern and central sections of the country, with a brief stay in Canada. The entertainment for the mission was largely arranged for by the Local Sections of the A. S. M. E. in conjunction with the local chambers of commerce of the various cities visited. The party will sail for Liverpool on or about July 5.

Austrian Engineers Appeal for Help

The Austrian Society of Civil Engineers and Architects, through its president, secretary and editor, has appealed to The American Society of Mechanical Engineers for relief for about 500 of the 4000 members who are without occupations and who are in distress.

Under the plan through which food drafts are sent to Austria through the American Relief Administration, 115 Broadway, New York City, the Austrian society is ready to deposit at a bank a sum in Austrian crowns equivalent to six times the present exchange for every dollar sent by Americans. This organization is further ready to distribute food not only among its own members but among all Austrian technical men who may call for help.

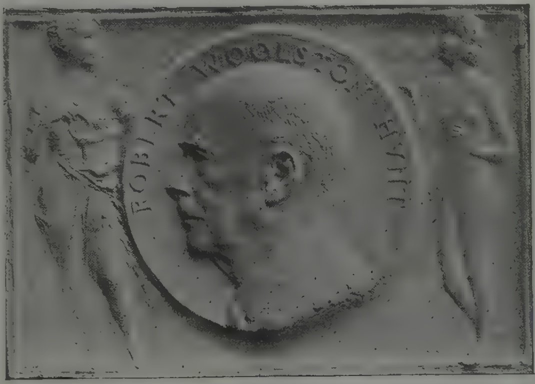
The Council of the A.S.M.E. received this appeal at its last meeting and refers it through the columns of Mechanical Engineering to those of the members who may wish to extend succor by sending food drafts.

Drafts may be obtained at any bank in this country and should be made available to the Austrian Society of Civil Engineers and Architects, Wien, 1, Eschenbachgasse 9, mailing them to the American Relief Administration. This system of food drafts is apparently very sure and any member sending help in this manner may be certain of its receipt.

The Robert W. Hunt Medal Fund

The eightieth birthday of Captain Robert W. Hunt was commemorated by the American Institute of Mining and Metallurgical Engineers by the presentation to him of the Hunt Medal for meritorious contributions to the art of making steel. The medal was designed and executed by Emil Fuchs, a medalist of international fame, and is considered, both from the point of execution and of symbolic significance, one of the most beautiful of any connected with the engineering profession.

The presentation ceremony took place on May 27 in the auditorium of the Engineering Societies Building. A. A. Stevenson opened the meeting and introduced John J. Cone, one of Captain Hunt's partners, who gave an account of the captain's career and his notable contributions to steel metallurgy. He then presented to the Institute on behalf of the associates and employees of Captain Hunt the Robert W. Hunt Fund, which consists of $7500, as an endowment fund to provide an annual award, and $1000 for the expenses of providing the medal. Herbert Hoover accepted the Fund on behalf of the Institute and, following a short speech by Charles M. Schwab, announced that the Iron and Steel Committee had awarded the first medal to Captain Hunt himself for his contributions to the steel industry, particularly the development of the steel rail. The ceremonies closed with a short speech of acceptance by Captain Hunt.



Slow Delivery of Mechanical Engineering Bulletin

The U. S. Post Office Department threw in low gear in the distribution of the "Mechanical Engineering Bulletin" issued to the A.S.M.E. membership in May. This bulletin was planned by the Sections Committee of the Society with the expectation that it might be issued at intervals and give prompt service in respect to Employment Bulletin items and important news notes. That the "prompt service" idea was missing in this first issue, at least in some cases, is evident from the fact that copies were not received in Cleveland until three weeks after the mailing date (May 19). This is an example of the many difficulties now experienced by those who are sending out large quantities of second and third-class mail matter. If it should be decided to continue the bulletin, the most that can be said is that we hope the Post Office Department may gradually get back into high-gear operation.

Organizing Conference Plans Federation of Engineering Societies

Delegates from 71 Engineering Organizations and Allied Technical Societies Adopt Constitution Creating "The Federated American Engineering Societies"—New Organization to Represent Profession in Matters of Common Concern and in National and State Affairs

IN a two-days' conference at Washington, D. C., June 3 and 4, which was marked by the intense enthusiasm of the attending delegates, the representatives of 71 engineering and allied technical societies took the first step toward the creation of an organization which should speak with a single voice for the engineering profession of the United States. This Organizing Conference, as it was known, was called by the Joint Conference Committee of the Four National Engineering Societies, who for some time past have been concerned with the problem of democratization of the profession and of effecting a closer coöperation between existing engineering and allied technical organizations. The conference thus called was a success in the highest degree, for with a fine disregard of unimportant details it adopted a constitution and by-laws of an organization to be known as "The Federated American Engineering Societies," a body composed of national, local, state, and regional engineering organizations which is to function through an "American Engineering Council."

CALVERT TOWNLEY
Chairman of the Conference

The opening session of the conference was called to order by Richard L. Humphrey, of the American Society of Civil Engineers, the chairman of the Joint Conference Committee. He reviewed the history of that committee and explained the basis of representation of delegates at the conference. He also spoke briefly of the need of a federation of engineering societies and of the value to the profession of such a body. Following Mr. Humphrey, Lt-Col. C. W. Kutz, U. S. A., engineer commissioner of the District of Columbia, welcomed the conference on behalf of the engineering societies of Washington.

The delegates then proceeded with the election of officers and Calvert Townley, past-president of the American Institute of Electrical Engineers, was chosen chairman, and John C. Hoyt, of the American Society of Civil Engineers, secretary. Dr. F. H. Newall, of the American Association of Engineers, then presented a resolution to the effect that the delegates of the conference have the full power to make rules governing its procedure. He also suggested that the conference proceed at once with the business of the day rather than adhere to the program as arranged by the committee. To these suggestions the conference readily assented.

Major G. S. Williams, of the Grand Rapids Engineering Society, thereupon at once offered the following resolution:

> *Resolved,* That it is the sense of the convention that an organization be created to further the public welfare wherever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical profession; and
>
> *Resolved,* That it is the sense of this convention that the proposed organization should be an organization of societies or affiliations and not of individuals.

This resolution was at once seconded and a spirited debate immediately ensued. The representatives of the American Associations of Engineers were the first to discuss the resolution. They argued for the creation of an organization composed not of societies or affiliations but of individuals, and they pointed out the advantages such a society would have for the individual engineer. They urged that their association be made the medium through which the entire engineering profession should speak in matters of federal and state concern and they appealed to all engineers to join their ranks.

Following the delegates of the American Association of Engineers, the representatives of the large national and the smaller local and regional organizations expressed their opinion as to the resolution, and it soon became evident that the conference was overwhelmingly in favor of a federation of existing societies and not of accepting any existing society to represent them nor of the formation of a new society composed of individuals.

The delegates who spoke in favor of the resolution urged its passage upon the grounds that an organization of organizations was the great need; a body which could represent the profession in such matters as concerned it as a group and not as individuals, as the interests of the individual, they claimed, were being well cared for by the existing national and local societies. The small local societies, particularly, were uniformly in favor of the resolution, and their representatives pointed out the value of a central organization through which they might be represented in federal and state matters, in which at the present time they are unable to participate.

When the resolution was put to vote, the societies voted in the order of their arrangement on the program, which was an alphabetical one. This placed upon the American Association of Engineers the necessity of voting first, and although they had argued against the resolution, nevertheless, sensing the wishes of the majority, they announced that their seventeen delegates voted aye. This announcement came as a great surprise to the conference, who at once voiced their approval by hearty applause. As the balloting continued it became evident that the resolution would easily pass, and when the secretary announced the final vote it showed that 119 delegates had voted aye, none had voted in the negative, and of the 71 societies present only five had not voted. This important decision of the conference taken so soon after it had convened showed the intense interest of the delegates in the movement and made clear their ability to act along broad, general lines without allowing themselves to be confused with details. The passage of the Williams resolution established beyond doubt the ultimate success of the movement and marked the first step toward the creation of the new organization.

JOHN C. HOYT
Secretary of the Conference

Following the vote on the resolution, Chairman Townley appointed three committees to deal with the details arising in connection with the conference. These were committees on constitution and by-laws, resolutions, and program. R. L. Humphrey was appointed chairman of the constitution and by-laws committee; Philip N. Moore, chairman of the resolutions committee; and

Robert H. Fernald, chairman of the program committee. These committees at once retired and the conference proceeded with the program as arranged by the Joint Conference Committee. This included addresses on the Functions of the Engineers in Public Affairs, by Arthur P. Davis, president of the American Society of Civil Engineers; Philip N. Moore, past-president of the American Institute of Mining and Metallurgical Engineers; and Leroy K. Sherman, president of the American Association of Engineers.

On Friday morning the conference began a consideration of the constitution and by-laws as prepared by the committee appointed the day previous. These were presented by Richard L. Humphrey, chairman of the committee, and after considerable discussion of their many details, both constitution and by-laws were passed in very nearly the same form as received from the committee. The vote on the constitution was particularly interesting in that it was indicative of the probable participation of the various societies in the new movement. Eight societies went on record as "present but not voting," among them being the American Association of Engineers. The final vote showed 88 delegates casting affirmative votes, ten absent and none against.

Following the announcement by Chairman Townley of the passage of the constitution and by-laws, L. P. Alford, chairman of the delegation representing The American Society of Mechanical Engineers, announced that the delegates who represented the Society were empowered to commit the organization, and that as soon as The Federated American Engineering Societies were ready to receive applications The American Society of Mechanical Engineers would apply for membership. The Society is thus the first organization to join the new movement.

The constitution, in accordance with the instructions of the conference, is now in the hands of an editing committee, and later MECHANICAL ENGINEERING will present it in its complete and finished form. The main features of the Constitution are:

Membership. Membership is to consist of national, local, state and regional engineering and allied technical organizations and affiliations, classified as follows:

(1) National engineering and allied technical organizations
(2) Local, state, or regional engineering or allied technical organizations other than local associations, sections, branches or chapters of national organizations
(3) Affiliations consisting of local sections of national organizations, local engineering societies or clubs and local engineers.

Management. The management of the new organization is to be vested in a body known as the American Engineering Council and its Executive Board. This Council is to consist of representatives of member societies each of which shall be entitled to one representative for a membership of from 1 to 1000, and one additional representative for each additional thousand members or a major fraction thereof. This Council is to hold an annual meeting. The elected officers of the Council will be a president, to hold office for two years, four vice-presidents, to hold office for two years, and a treasurer, to hold office for one year. An executive officer who shall also be secretary is also provided. The Executive Board is to consist of thirty members of the Council, and this Board is to conduct the business of the new organization under the direction of the Council. The six officers selected by the Council are to be members of this Executive Board, and the balance of twenty-four shall be selected by the National Societies and local, state and regional organizations according to districts. The president and secretary of the Council shall be, respectively, the chairman and secretary of the Executive Board.

Funds. The funds for the use of the new organization are to be obtained in the following manner: Each national member society represented on the Council is to contribute annually $1.50 per member. Each local, state or regional organization represented is to contribute annually $1 per member.

Local Affiliations and State Councils. The Council is empowered to encourage the formation of local affiliations to consider matters of purely local public welfare with which the engineering profession is concerned. It is also authorized to create state councils consisting of representatives of the local affiliations within the state. These councils are also for the purpose of considering matters of public welfare as associated more particularly with state matters.

Evening sessions were held at the New Willard Hotel on both days of the conference. On Thursday evening the delegates were addressed by Homer L. Ferguson, past-president of the United States Chamber of Commerce; James H. McGraw, president of the McGraw-Hill Publishing Co. of New York; and George Otis Smith, director of the United States Geological Service, Washington, D. C. On Friday evening addresses were given by Samuel M. Vauclain, president of the Baldwin Locomotive Works, Philadelphia, Pa.; Robert S. Woodward, president of the Carnegie Institution, Washington, D. C.; and James R. Angell, chairman of the National Research Council, Washington, D. C. All of these addresses were highly inspirational to the delegates assembled, and it is to be regretted that space will not afford even a brief comment on them. E. W. T.

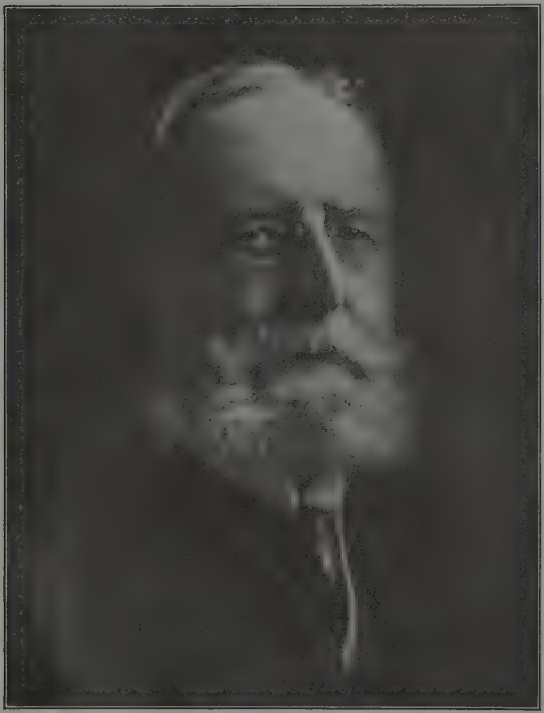
ORGANIZATIONS PARTICIPATING IN CONFERENCE

American Association of Engineers
American Association of Petroleum Geologists
American Ceramic Society
American Concrete Institute
American Electric Railway Engineering Association
American Electrochemical Society
American Institute of Electrical Engineers
American Institute of Mining and Metallurgical Engineers
American Ordnance Association
American Railway Engineering Association
American Society of Agricultural Engineers
American Society of Civil Engineers
American Society of Heating and Ventilating Engineers
American Society of Mechanical Engineers
American Society of Naval Architects and Marine Engineers
American Society of Refrigerating Engineers
American Society of Safety Engineers
American Society for Testing Materials
American Water Works Association
Associated Engineering Societies of St. Louis
Associated Engineers of Spokane
Association Railway Electrical Engineers
Boston Society of Civil Engineers
Brooklyn Engineers' Club
Cleveland Engineering Society
Colorado Society of Engineers
Connecticut Society of Civil Engineers
Detroit Engineering Society
Duluth Engineers' Club
Engineers' and Architects' Club of Louisville
Engineers' Club of Baltimore
Engineers' Club of Columbus
Engineers' Club of Minneapolis
Engineers' Club of Philadelphia
Engineers' Club of St. Louis
Engineers' Club of Trenton
Engineering Council
Engineering Society of Akron
Engineering Society of Buffalo
Engineers' Society of Pennsylvania
Engineers' Society of Western Pennsylvania
Florida Engineering Society
Grand Rapids Engineering Society
Illinois Society of Engineers
Illuminating Engineering Society
Indiana Engineering Society
Institute of Radio Engineers
Iowa Engineering Society
Kansas Engineering Society
Los Angeles Joint Technical Society
Mining and Metallurgical Society of America
Minnesota Surveyors' and Engineers Society
Mohawk Valley Engineers' Club
Nashville Engineering Association
National Fire Protection Association
National Safety Council, Engineering Division
New England Water Works Association
Oregon Technical Council
Providence Engineering Society
Scientech Club
San Francisco Joint Council of Engineering Societies
Society of American Military Engineers
Society of Automotive Engineers
Society of Engineers of Eastern New York
Society of Industrial Engineers
Society for the Promotion of Engineering Education
Taylor Society
Technical Club of Dallas
Topeka Engineers' Club
Vermont Society of Engineers
Washington Society of Engineers

EDMUND GYBBON SPILSBURY

On May 20, 1920, Edmund G. Spilsbury, mining and metallurgical engineer of international reputation, died suddenly after many years of useful service to the profession and to the engineering societies.

Mr. Spilsbury was born in London, England, in 1845. He was educated in Belgium and was graduated from the University of Louvain in 1862. He then took up practical work in Germany, entering in 1864 the service of the Eschweiler Zinc Co., Stolberg, one of the largest miners and smelters of lead and zinc in the world. The following year he was given charge of that company's mines and works in Sardinia. In 1867 he became connected with McClean and Stillman, of London, in charge of the construction of the lock gates for the Surrey Commercial Docks; in 1868 he accepted the position of designing engineer with J. Casper Harkort and was assigned to the detail work of the Keulenberg Bridge in Holland, the Danube Bridge at Vienna and the Rhine Bridge at Düsseldorf. Later he returned to the Eschweiler Company as chief engineer, and in 1870 came to the United States for the Austro-Belgian Metallurgical Co. to investigate the resources of this country in lead and zinc.



Edmund Gybbon Spilsbury

After two years in this country Mr. Spilsbury decided to take up practice here, in the course of which he introduced the Harz system of ore dressing for the zinc ores of Pennsylvania and New Jersey. During this period he was also engaged in explorations on the northern shore of Lake Superior and in Colorado, Montana, Utah and California. From 1873 to 1875 he was engaged as general manager of the Bamford (Pa.) Smelting Works; in 1879 he designed and built the Lynchburg Blast Furnace and Iron Works; he was also consulting engineer for the Coleraine Coal & Iron Co., Philadelphia. In 1883 he became general manager of the Hailer Gold Mine in South Carolina and in 1887 became connected with Cooper, Hewitt & Co., New York. From 1888 to 1897 he was managing director of the Trenton Iron Co., Trenton, N. J. While manager of these works he introduced as specialties of their business the Elliot locked wire rope and the Bleichert system of aerial tramways.

His practice as a consulting mining engineer and metallurgist took him into many parts of Europe, Africa, the United States, Mexico and South America. During the winter and early spring of 1920 he spent a number of weeks in Brazil on a mining project for clients in the United States and had returned to the United States only a few weeks prior to his death.

Mr. Spilsbury was the author of a number of important technical papers, mostly on mining processes and on mine appliances. He also wrote entertainingly in a lighter vein, and the following paragraphs from "Technical Reminiscences," published in *Mining and Scientific Press* in 1915, recall early interesting experiences.

> Early pioneer work in Sardinia was most interesting and instructive. In the first place, the island was almost as much a terra incognita as our own West a century ago. And yet the civilization of Sardinia was one of the oldest in the world. The Phoenicians, the Egyptians, and later the Carthaginians and the Romans, had all left their marks, in old excavations, dumps, slag piles and more especially in the tombs cut out of solid rock. In the early 60's the northern and eastern parts of the island were dangerous, as well as difficult of access. The tribes occupying this mountainous district did not recognize the Italian Government and were generally classed as bandits. During the second year of my stay one evening I heard a disturbance outside my camp and the clatter of a number of horses. Thinking that I was about to be raided by the bandits, I called the two foremen who were in the house and, getting our guns, we started to see what the trouble was. Opening the door, I saw a small cavalcade. The leader was a very tall and slim young gentleman, dressed in full hunting costume. He addressed me by name, stating that he had a letter of introduction and asking if he and a friend could stay the night. I thought I had never seen a taller or lankier fellow, but withal, a most pleasant face. He handed me a letter from one of the directors of our company, asking me to make the stay of the bearer as pleasant as I could, as he was a friend of theirs, being the Duke of Brabant, afterward Leopold the Second, King of the Belgians. The Duke had come to Sardinia on a mountain sheep hunt. Years afterward, when he had succeeded his father, I always received a hearty welcome whenever I met him either in Brussels or Paris.

And again we find these paragraphs telling of the changes which have taken place in mining practice:

> I wonder how many mining engineers of the present day can call to mind changes and advances in the practice of mining which have taken place in the last half century? Practically every appliance beyond the pick and shovel, hand hammer and drill, has been introduced during that short period. When I first started my practical course in underground work, we knew none of the aids now considered requisite to work economically. We had no machine drills to save the physical labor of hand work. Dynamite or its precursor, nitroglycerine, had not yet been invented; fuse was still unknown; even steel was more or less of a luxury, and our hand drills were still made of iron with steel bits welded on to them. The mushrooming of the head of the drill under the hammer blows was a constant source of trouble and injury to the hands of the miners. The only explosive known was the large-grained black powder.
>
> It seems hardly credible today, and yet it is a fact that the contract price for driving or stoping ground was influenced by the condition of the rye crop. In seasons of drought, the height of the rye was much curtailed and the length of the straw between joints would be so short that the time occupied in jointing and filling the stalks which were used as fuses, greatly lessened the driving capacity of the miners. The straw primers naturally limited the possible depth of the hole and three feet was considered a good average. These straw fuses were very rapid and it was necessary to ignite them by a slow-burning sulphur wick.

Mr. Spilsbury was intensely interested in the work of the national engineering societies. He was a member of the American Institute of Mining and Metallurgical Engineers, of which he was president in 1896, the American Society of Civil Engineers, the Institution of Mining and Metallurgy of Great Britain, the Mining and Metallurgical Society of America, and the American Electrochemical Society; he became a member of The American Society of Mechanical Engineers in 1890. In 1916-17 he was president of the Engineers' Club of New York. He was a trustee of the United Engineering Society from 1916 until his death; a member of the Engineering Societies Library Board from its organization in 1913 and a member of the Engineering Foundation Board from 1916. He was also a member of the National Research Council. In all these associations he was an active and useful member and served on numerous committees and contributed freely of his time and ability.

Industrial Relations Association of America

Earnest Convention at Chicago Considers Vital Problems—"Educating with Truth" a Solution of Industrial Relations—Union Officials Boast of Increasing Production

THE Second Annual Convention of the Industrial Relations Association of America was held in Chicago at the Auditorium on May 19, 20 and 21. Organized in 1918 as the National Association of Employment Managers, its rapid growth and the appreciation of the breadth of the field led to the change in name.

To understand the spirit that permeated this gathering, one must picture one of the old-time preaching services lasting several days, people coming from all the countryside, listening to hour sermons with divine expectation, and sitting through long experience meetings, all in the hope of guidance in solving their daily problems. The Chicago convention of the I. R. A. A. was just such a meeting. Managers came to Chicago from east and west, from small plant and from large plant, 2500 in all, with a determination to absorb every portion of the great feast of information provided. Glimpses of receptive notebooks and poised pencils gave an impression accentuated by the earnest faces and quick shouts of "louder," if the speaker dropped his voice even momentarily, that these people were hard against the big problem in industry today, that of the relation of workmen and employer, and that they were seeking every atom of help from the knowledge and experience contributed at the convention.

The plan of the convention was based on the principle that every one of the twenty-five hundred in attendance should be given opportunity to check up his individual stock of experience with that of those attacking similar problems or engaged in similar industries. Thirty-three round-table subject luncheons were arranged at which topics such as Employment Office Methods, Radicalism, Americanization, Developing Plant Spirit, Housing and Introducing the New Worker, were considered under the guidance of capable leaders. At dinner those working in the same industry met for a consideration of the problems peculiar to that industry. The main sessions of the convention were given over to a treatment of the important phases of the industrial relations problem by well-known and properly equipped speakers.

In the opening address Cyrus H. McCormick, works manager of the International Harvester Co., laid down the principle that truth and its wide dissemination was the only firm basis on which lasting coöperation between employers and employees can be built. He stated the duty of the employment manager to be the education of the employees and emphasized the importance of the proper fulfilling of this duty.

Incentives and Their Relation to Production were discussed by L. C. Marshall, dean of the School of Commerce and Administration, University of Chicago, and Frank J. Raymond, of the Inter-Racial Council of New York.

The importance of having each workman understand the part he is playing in the complete scheme of manufacture and the effect of the individual's effort on the finished product, was handled by H. B. Bole, vice-president, Hydraulic Pressed Steel Co., Cleveland, and Harry N. Clarke, president, The Cort-e-Scope Co., Cleveland. They outlined methods successfully used in giving their men a perspective of the entire operation of their plants.

C. A. Lippincott of South Bend, Ind., told of the housing scheme developed by the Studebaker Co. as a solution of the problem of community conditions affecting labor stability. The Studebaker plan is to build the houses and sell them to their workmen, loaning the money without interest. Mr. Lippincott paid his respects to the professional uplifters with the words, "Man does not need a gratuity. The activities of some welfare associations seem to intimate to the person to whom so-called succor is to be given, that he is in the mire and needs uplifting, such as they only can render."

In her talk on the Status of Women in Industry, Mary Van Kleck of the Russell Sage Foundation scouted the idea that women should receive special treatment as a peculiar problem in industry and spoke forcefully in favor of considering women's place in every phase in industry. Treating the subject of employee representation, Miss Van Kleck pointedly questioned the exploitation of industrial representation as a means of forcing false ideas of loyalty down the throats of employees, and stated as her real opinion that representation honestly offered by the employer would have a wonderful effect in bringing out leadership and developing true democracy.

The vital problem of the foreman and his relation to the organization and to the workman received special consideration. Dudley R. Kennedy, of Philadelphia, formerly in charge of industrial relations at Hog Island, touched the spot in his talk: "It's high time we stopped blaming the Reds and the agitators for the prevailing conditions and hang the blame where it belongs. If the radicals can do more with our men in two hours at night than we can, having them at our command for eight hours a day, then something is radically wrong. The fault lies at the top. "Industry must open its books to the workers. Also we must equip our foreman to answer the absurdities of the soapbox orators. Production has fallen off, not primarily because of derelictions among the workers, but because leadership isn't present, and it is up to management to provide the leadership." Mr. Kennedy's talk was emphasized by Leroy Kramer, vice-president of the Willys-Overland Co., of Toledo, who said that the foreman must be closer to the management of the plant than he is, so that he may be in a position to give the workers the truth, rather than permit them to get half-truths or untruths from irresponsible agitators.

One of the peaks of enthusiasm of the convention was reached at the close of E. J. McCone's speech stating his position on the open-shop question. Mr. McCone, general manager of the Buffalo *Commercial*, recently testified before the Senate committee that every newspaper in the country, except three, are subject to censorship of the typographical union. His subject was Organized Labor in Industry, and he made the plea for democracy in unionism and the right of an individual to join a union or not.

Mr. McCone spoke with an eloquence and enthusiasm that, at his closing words, brought the convention to its feet with applause and cheers. Sidney Hillman, President of the Amalgamated Clothing Workers of America, speaking on the same subject, uttered a new note in the call of organized labor. He stated the principal question of the day to be, "Shall humanity be starved to death through lack of production?" and pleaded for an industrial relationship that will establish a coöperation leading to greater production. Mr. Hillman outlined the work his union had done in bettering the conditions of the workmen in the clothing industry and quoted one of the employers who admitted that the organization had increased production in his shop. In closing, he made an earnest plea for a careful study of the industrial situation by the best minds of the country so that decisions in the future would be based on facts rather than the opinions advanced by glib talkers.

Sherman Rogers, of New York City, a former lumber jack and a man who has spent his life with the workmen, testified that what the workman wanted most today was the truth. He expounded forcefully his theory that placing the cards flat on the table was the only way to settle present conditions and he illustrated, from his experience, how Bolshevism had been checked and strikes forestalled by plain statements of the facts in the case.

What the workman thinks about modern employment methods and welfare work was illuminatingly explained by Whiting Williams, of Cleveland, who told how he was treated when he doffed his white collar and was hired and fired in shops and factories throughout the country. Severe though his comments were on the way men are treated, they were justly and graciously received by the convention. He showed the importance of a broad point of view in handling industrial relations and the necessity for dignifying the employment manager's job.

Broadly stated, according to the principal speakers the solution of the problem of satisfactory industrial relations lies along the open recognition by the employer that his leadership depends on the confidence he places in his men and in the way he takes his men into his confidence.

The convention relaxed from its inspiring work for one evening when it presented "An Industrial Jamboree," a satirical burlesque on the Second Industrial Conference. All the characters were represented and their testimony before the conference of disagreements brought peals of laughter from the convention.

Plant visitation trips included the Stock Yards, the International Harvester Co., General Electric Co., Illinois Steel Co. and other smaller plants that have achieved success with their industrial relations work. C. E. D.]

MOTOR GASOLINE FROM HEAVIER HYDROCARBONS

(*Continued from page* 402)

It is becoming the practice to utilize heavy distillates for the purpose of cracking rather than the residual oils. In this way the amount of coke produced during the operation is materially lessened. For example a heavy asphaltic oil may be distilled to coke at atmospheric pressure and certain of the distillates used for the purpose of cracking.

Composition and Refining of "Cracked" Distillates. Unrefined "straight run" or "natural" gasoline distillates are composed of varying proportion of paraffins, naphthenes, aromatics, small percentages of olefines and a quantity of organic nitrogen and sulphur compounds generally small, but depending upon the character of the original crude petroleum. Oxygen compounds such as naphthenic acids may also be present in traces. Some of the straight-run gasolines which have been secured where direct steam was used in the distillation process necessitate little or no treatment with sulphuric acid.

The gasoline distillates produced by "cracking" contain diolefines in addition to the compounds mentioned above while the proportions of aromatics are larger. Cracking in the vapor phase only, because of the higher temperatures generally employed, produces larger proportions of unsaturated hydrocarbons and aromatics than in the case of the pressure still.[18] Cracked distillates upon standing may separate a resinous product which is derived, no doubt, from the diolefines and possesses explosive properties when heated.[19] The disagreeable odor of these distillates is attributed by some to the unsaturated hydrocarbons, particularly the diolefines. Brooks and Humphrey,[20] however, record that this disagreeable odor is to be attributed more to the presence of organic nitrogen, oxygen and sulphur compounds.

Sulphuric acid acts both chemically and physically upon unrefined distillates, colloidal coloring matter being precipitated and dissolved by the acid, unsaturated hydrocarbons, nitrogen, sulphur, and oxygen compounds entering into reaction, the three last mentioned being by no means completely removed. The rise in temperature which is especially marked in the case of unrefined "cracked" distillates when treated with sulphuric acid is no doubt largely influenced by the diolefines. According to Brooks and Humphrey, the lower olefines react to form alkyl esters, tertiary and secondary alcohols, some polymerization also taking place. Above the hydrocarbon $C_{12}H_{24}$ polymerization takes place to form di- and tripolymers which contain but one double bond. Brooks and Humphrey also made the interesting discovery that the higher olefines such as those found in the residual oils and in lubricating oils are but slightly reactive with concentrated sulphuric acid. In the case of gasoline distillates these polymers dissolve mainly in the hydrocarbon layer, raising the final boiling point. Likewise, neutral esters of sulphuric acid remain in the gasoline and are not removed when the product is washed with alkali solution; upon standing the product is likely to precipate a resinous, viscous layer due to these esters.

It is well known that the "cracked" distillates are more difficult to refine successfully than the "natural" products. The loss is likely to be large and the resultant product may be colored. Ellis and Wells[19] report that by hydrogenation of "cracked" gasoline was secured a water-white product, but they do not give the specific method used nor the constants for the gasoline before and after treatment.

Brooks and Humphrey[20] recommend that the unrefined product be treated with not more than 6 per cent of 85 to 90 per cent sulphuric acid, followed by *redistillation.*

Experiments Undertaken by the Author. In order to determine practical refining conditions for "cracked" distillates, as far as *color, odor,* and *stability* are concerned, the writer and his students have carried out some experiments upon "cracked" distillates from commercial pressure stills. Constants on the unrefined pressure gasoline distillate and the natural gasoline distillate, both from the same crude petroleum mixture, were determined as follows:

	Crude Straight-Run Gasoline	Crude Pressure Still Gasoline
Gravity, deg. Bé	57.7	54.3
Refractive index	1.4142	1.4252
Heat of reaction with sulphuric acid (1.84 sp. gr.), deg. fahr.	1	11
Loss of sulphuric acid (room temp.), per cent	9	16
Loss of sulphuric acid (32 deg. fahr.), per cent	5	8

The experimental work undertaken upon the refining of cracked distillates has developed in such an interesting way that the work may be considered as only begun. The best results from the standpoint of both color and odor were secured by direct treatment of the pressure still gasoline with concentrated (1.84) acid at 32 deg. fahr. followed by redistillation. The color of the product did not deepen after the sample had been exposed to the light (sunlight part of the time) for approximately 30 days.

Other most interesting results have been secured but it is not advisable to discuss them at this time until further experiment and verification.

A Census of Special Libraries

Because of the fact that there does not exist an adequate directory of special libraries, the Special Libraries Association is now actively engaged in determining the number of such institutions throughout the country. During the war, when army camps and military centers were being furnished with libraries for research and educational work, the lack of a satisfactory list of information centers was keenly felt. There were a large number of occasions when army men could have used a directory of institutions or corporations having special libraries if such a publication had been in existence. It is to fill such a want that the present census is being taken.

A special library has been defined as a good working collection of information upon a specific subject or field of activity; it may consist of general or even limited material serving the interests of a special clientele, and preferably be in charge of a specialist trained in the use and application of the particular material. Libraries coming within the above qualifications are earnestly requested by the Special Libraries Association to supply the following information:

1 Name of institution or company
2 Name by which library is known
3 Name of librarian or custodian
4 Can it be classified as any of the following: financial; business; legal; engineering or technical; institutional; municipal; reference; agricultural?
5 Does it serve a special clientele?
6 Would your librarian be willing to assist other special libraries to a reasonable extent?

These data should be sent to the Chairman, Library Census Committee, care of General Electric Company, Schenectady, N. Y.

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[18] Where steam is used with the oil vapors, it is claimed that this condition does not obtain and that a sweeter product is obtained.

[19] See Ellis and Wells, Jour. Ind. Eng. Chem. 7 (1915), 1029.

[20] Brooks and Humphrey, Jour. Am. Chem. Soc. 40 (1918), 822.

THE ENGINEERING INDEX

(*Reg. U. S. Pat. Off.*)

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THE following pages form a descriptive Index to articles on engineering and related subjects which have appeared in current technical periodicals. In its preparation the Society's engineering staff regularly reviews all of the technical journals and society publications received by the Engineering Societies Library. These form one of the greatest and most complete collections of scientific periodicals in the world and comprise upward of 1100 distinct publications in some ten languages. The Index is alphabetically arranged with numerous cross-references, the items being placed under appropriate subject headings. The main abbreviations used in the items are given at the bottom of this page.

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ACCIDENTS

Hospital Work in Shop

Hospital Work in a Large Machine-Tool Plant, Sanford De Hart. Am. Mach., vol. 52, no. 13, Mar. 25, 1920, pp. 658-660, 3 figs. Experience of R. K. Le Blond Machine Tool Co., Cincinnati. Safety, sanitation and health work in that plant are under supervision of hospital department, personnel of which consists of the writer, a surgeon, a dentist and a stenographer.

AERONAUTICAL INSTRUMENTS

Construction, Testing and Use

Aeronautic Instruments, Mayo D. Hersey. Mech. Eng., vol. 42, no. 5, May 1920, pp. 263-268, 4 figs. Paper on general principles of their construction, testing and use, based on work of Aeronautic Instruments Section of Bur. of Standards.

AERONAUTICS

Lexicon

Technical Terms in Aeronautics (Flugtechnische Fachsprache), E. Everling. Motorwagen, vol. 22, no. 34, Dec. 10, 1919, pp. 647-652. Gives German equivalents for large number of English aeronautical terms. Report from German Experimental Station for Aerial Traffic.

Research

The Advisory Committee for Aeronautics. Flight, vol. 12, no. 17, Apr. 22, 1920, pp. 439-442. Summary of work done by British Advisory Committee for Aeronautics for 1918-1919, noting specially expansions which have been necessitated in experimental work in order to cope with demands from Royal Air Force and British aeronautical industry.

[See also FLIGHT.]

AERONAUTICS (MILITARY)

Camouflage

Aeronautical Camouflage, Wm. R. Weigler. Aerial Age, vol. 11, no. 9, May 10, 1920, pp. 288-289 and 300, 5 figs. Experiments at McCook field on model aeroplanes. Camouflage design is explained which is said to accomplish invisibility at 15,000 ft. of plane normally invisible at 20,000 ft. Curve plotted by Bureau of Standards, which shows, in terms of wave length of light and amount of transmission, effect of visibility of various colors, is included.

AEROPLANE ENGINES

Horsepower Variation with Temperature

Variation of Horsepower with Temperature, H. C. Dickinson, W. S. James and G. V. Anderson. Aerial Age, vol. 11, no. 5, Apr. 12, 1920, pp. 154-157, 11 figs. Results of experiments with two Hispano-Suiza engines and three different makes of carburetors. Correction factor has been determined which varies with engine and carburetor conditions, but is believed to be approximately correct for type of engine under consideration and for temperatures between —20 deg. and 50 deg. cent. Curves showing graphically value of correction factor are shown and charts for correcting both temperature and barometric pressure are given.

Liberty, Outlet Water Temperature

Effects of Water Outlet Temperature on Engine Output. Automotive Industries, vol. 42, no. 18, April 29, 1920, pp. 1002-1003 and p. 1008, 5 figs. Tests made with Liberty engine to determine optimum water temperature are said to have established that best water outlet temperature is 170 deg. fahr. Tests were made at McCook Field by Air Service Engineering Division.

Lubricating Oil for

Liberty Aero Oil, William F. Parish. Jl. Am. Soc., Naval Engrs., vol. 32, no. 1, Feb. 1920, pp. 45-98, 30 figs. Specifications for mineral lubricating oil for use on aircraft engines of stationary cylinder type, prepared by Oil and Lubrication Branch, Air Service, U. S. Army in coöperation with various oil manufacturers. Oil is required to be a pure, highly refined petroleum product with viscosity at 212 deg. fahr. on Saybolt universal viscosimeter from 85 to 90 sec. for low-specific-gravity oils and from 70 to 75 sec. for high-specific-gravity oils. Flash point, pour test and carbon residue are also specified.

Paris Show

The Aeronautical Salon (Salon Aéronautique), Jean-Abel Lefranc. Nature (Paris), no. 2396, Apr. 3, 1920, pp. 133-138, 12 figs. Aeroplane engines exhibited at Paris aeronautical show. Comparative schemes of engines with 6, 12, 18 and 24 cylinders are shown.

Performances

Flying an Airplane Engine on the Ground, S. W. Sparrow. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 239-244, 14 figs. Account of tests conducted at altitude chamber of dynamometer laboratory at Bureau of Standards. A set of standard comparative engine tests was selected for predicting value of engines for given service. These tests included (1) full-power runs at ground altitude over speeds ranging from 1200 to 2200 r.p.m., (2) full-power runs at two speeds and at altitudes ranging from ground level to 25,000 ft., (3) propeller load runs at altitudes of 5000, 10,000 and 15,000 ft., and (4) friction-horsepower runs.

Piston Alloy

See MAGNESIUM ALLOYS.

Piston Rings

Science in the Foundry. A. Harley. Foundry Trade Jl. & Pattern Maker, vol. 22, no. 220, April 1920, pp. 265-269, 7 figs. Practical conditions of scientific organization in foundry are pointed out, particularly with regard to storage and transport of material and systematizing production. Manufacture of piston rings for aeroplane engines is also taken up, and in this connection specifications are suggested for metal for piston rings. Paper read before Instn. of British Foundrymen.

Power at High Altitudes

Maintaining Airplane Engine Power at Great Altitudes, V. E. Clark. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 245-249, 7 figs. Performances obtainable at different altitudes with various assumed ratios of actual engine power at altitude to total weight of airplane, are computed for DeHaviland-Four, which is taken as typical of present practice.

Power Maintenance Without Supercharging

The Power Recuperating Engine, George Funck. Automobile Engr., vol. 10, no. 137, April 1920, pp. 145-153, 18 figs. Theoretical study based on entropy characteristics of gasoline engines. Two classes of engines are proposed for maintaining power at high altitudes without supercharging—(1) those having cycle of operations such as to maintain a maximum pressure, and (2) those which maintain a constant compression temperature—taking into account for both the atmospheric temperature variation. Mechanical means are suggested for operating these cycles.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Macby.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ENGINEERING INDEX (Continued)

Radiators and Cooling Systems

Radiators and Cooling Systems for Aircraft Engines, R. N. Liptrot. Aeronautics, vol. 18, no. 341, Apr. 29, 1920, pp. 345-347, 1 fig. Data on heat to be dissipated by radiator, obtained in experiments at various aeronautical laboratories, are quoted, and rules are formulated for designing radiators and cooling systems for aeroplane engines. (To be continued.) Paper read before Inst. Aeronautical Engrs.

Supercharging, Value of

Flight at Very High Altitudes and the Use of Turbo-Compressors (Quelques considerations sur les vols aux très grandes altitudes et sur l'emploi du turbo-compresseur), M. A. Rateau. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 13, March 29, 1920, pp. 782-788. Value of supercharging for reaching high altitudes is concluded from recent records attained with engines fitted with turbo-compressors. Reference is particularly made to ascent to 36,020 ft. by R. W. Schroeder of U. S. Air Service.

Sunbeam-Coatalen

The 12-Cylinder 800/900 H.P. Sunbeam-Coatalen Aircraft Engine. Aerial Age, vol, 11, no. 7, April 26, 1920, p. 221, 2 figs. Dimensions: Bore of cylinders, 180 mm. (7.086 in.); stroke of cylinders, 210 mm. (8.268 in.); normal speed of propeller, 920 r.p.m.; weight of engine complete without fuel, water or oil, 1952 lb.

AEROPLANES

Aerofoils

An Introduction to the Study of the Laws of Air Resistance of Aerofoils. Nat. Advisory Committee for Aeronautics, report no. 28, 1920, 75 pp., 59 figs. Apparent flow deflection produced by aerofoil is examined, as well as intensity and direction of tip vortices. Possibility of formation of two waves behind an aerofoil is studied, and numerical values of the order of their magnitude are included. Discussion of Kutta theorem, generalization of Bernouilli theorem, and equations of metacentric curves are appended.

Avro Triplane

Avro Triplane Type 547. Aerial Age, vol. 11, no. 5, Apr. 12, 1920, pp. 152-153, 5 figs. Specifications: Overall length, 29 ft. 10 in.; overall height, 14 ft. 4 in.; weight loaded, 3000 lb.; max. speed, 94 m.p.h.; engine, 160 hp. Beardmore 6-cylinder.

Boulton & Paul

The Boulton & Paul Commercial Machine. Aerial Age, vol. 11, no. 9, May 10, 1920, pp. 290-292, 4 figs. Specifications: Weight, loaded, 7000 lb.; speed at 10,000 ft., 149 m.p.h.; at 15,000 ft., 142 m.p.h.; climb to 10,000 ft.. 8 min.; to 15,000 ft., 15 min.; ceiling, 25,000 ft.: load per sq. ft., 8.4 lb.; load per hp., 7.7 lb.

Climb, Determination of

Graphic Determination of Climb of an Aeroplane from the Barogram (Graphische Bestimmung des Steigmasses eines Flugzeuges aus dem Barogramm), E. v. Lössl. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 10, no. 23-24, Dec. 27, 1919, pp. 274-277, 4 figs. Method is outlined for studying aerodynamic quality of an aeroplane by characteristic ratio.

Commercial Type

The Commercial Airplane in Its Present Day Development, George E. Quisenberry. Automotive Industries, vol. 42, no. 18, April 29, 1920, pp. 998-1001, 4 figs. Progress made in Europe is specially pointed out, and in this connection reference is made to Caproni triplanes having seating capacity of 20 passengers, Airco nine-passenger single-engine plane designed for London-Continental service, and proposed Grahame-White nine-seater limousine which mounts two 320 hp., Rolls-Royce Eagle V engines.

Design of

Handbook of Instructions for Airplane Designers. Eng. Division Air Service, Feb. 1920, 142 pp., 77 figs. It is divided into the following sections: Airplane design (materials, structures, etc.); propellers; power plant installation; armament installation; equipment installation; and weight schedule.

Fire Protection for

Aeroplane Fires (La descent en flammes). Aérophile, vol. 28, no. 3-4, Feb. 1-15, 1920, pp. 48-49. Manner in which aeroplanes caught fire in war operations is explained, and protective remedies devised by allied powers, notably France, are classified and briefly described.

Forest Patrol Service

Airplane Patrol of the Forests, F. A. Elliott. Am. Forestry, vol. 26, no. 316, April 1920, pp. 206-208, 4 figs. Organization of patrol squadron for inspecting regularly 28,000,000 acres of timber, brush and cut-over land which constitute a fire risk in Oregon. Squadron is to consist of 18 planes, 180 men, from 30 to 40 officers, carrier pigeon lofts, and is to include photographic and radio section.

Helicopters

Braking Effect or Negative Traction Produced by Uncoupling the Propellers of a Helicopter in Vertical Descent (Freinage ou traction négative des helices sustentatrices débrayées dans in descente planée verticale d'un helicoptère). Aérophile, vol. 28, no. 3-4, Feb. 1-15, 1920, pp. 50-53, 3 figs. When helicopter falls vertically, propellers, if free, will rotate and thereby take up energy of descent. It is calculated theoretically that such braking effect is probably insufficient to regulate descent within limits of safety. Experiments are suggested to investigate question further along lines which by theory alone cannot be fully investigated at present.

Junker Monoplane

The Junker Single-Seater All-Metal Monoplane, Type D1. Flight, vol. 12, no. 16, April 15, 1920, pp. 419-422, 12 figs. Corrugated fuselage covering finishes in vertical plane just in front of tail planes and rear body portion is built up integrally with fixed tail planes. Armament consists of two Spandau guns fixed on channel duralumin bearers immediately in front of pilot. (Concluded.)

Knots

The Employment of Knots in the Construction of Aeroplanes (Ueber die Anwendung des Knotens im Flugzeugbau), Ludwig Grüter. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 10, no. 23-24, Dec. 27, 1919, pp. 267-270, 24 figs. Description and illustrations of various forms of knots, of which one is specially recommended, directions being given for most practical manner of making it.

Landing Runs, Braking Systems for

Landing Run and Get-Away for Standard Airplanes, Alexander Klemin. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 231-236, 9 figs. Technical study of various systems of braking and of devices for shortening landing runs. Reference is made to investigations by Nat. Advisory Committee for Aeronautics, from which investigations it is concluded that for a given size of propeller, wide blades have a larger brake effect than narrow blades, and that brake effect of higher-pitch propeller is less than that of lower-pitch propeller.

Models for Tests

Construction of Models for Tests in Wind Tunnels. Nat. Advisory Committee for Aeronautics, report no. 74, 1920, 19 pp., 47 figs. Process of manufacturing single aerofoil for determining aerodynamic properties of sections.

Orenco

The Orenco Type "F" Tourister Aeroplane. Aerial Age, vol. 11, no. 8, May 3, 1920, pp. 253-256, 10 figs. Specifications: Engine, Hispano-Suiza Model A, 150 hp.; weight fully loaded, 2432 lb.; useful load, 955 lb.; range at full speed, 250 miles; speed near ground, 90 m.p.h.; at 5000 ft., 84 m.p.h.; at 10,000 ft., 78 m.p.h.; climb to 15,000 ft., 62 min.; overall length, 25 ft. 10 in.; overall height, 9 ft.; span, 38 ft.

Paris Show

Aeroplanes in the Sixth Salon of the Paris Show (Les avions actuels et le 6 salon de l'Aéronautique). Aérophile, vol. 28, no. 3-4, Feb. 1-15, 1920, pp. 33-47, 43 figs. Characteristics and dimensions of types exhibited.

Radio Communication

Reception Control Experiments on Aeroplanes (Ueber Richtempfangsversuche im Flugzeug), Eberhard Buchwald and Rudolf Haase. Jahrbuch Zeitschrift für drahtlose Telegraphie u. Telephonie, vol. 15, no. 2, Feb. 1920, pp. 101-113, 9 figs. Methods developed for flow measurements were adapted for the receiving conditions of an aeroplane, with the result that it became possible under the most unfavorable circumstances to carry out quantitative reception measurements of an objective nature on aeroplane. Results of investigations carried out during 1917 and 1918 on Döberitz and the Lärz aviation fields.

Ranges and Useful Loads

A Study of Airplane Ranges and Useful Loads, J. G. Coffin. Nat. Advisory Committee for Aeronautics, no. 69, 1920, 29 pp., 11 figs. Relation between useful load and range is worked out by two methods, one involving usual performance estimate, the other based upon theoretical considerations. Among results obtained are the following: Machine should fly at constant angle of attack, angle corresponding to minimum value of (weight)/(total resistance); it is immaterial whether machine flies high or low as far as range is concerned; resistance is proportional to weight at given altitude; and times of flight at same level for flying at best range speed and at minimum power speed are practically the same.

Rudder Moment

Rudder Moment Measurements on an Aeroplane in Flight (Ruder-Moment-Messungen an einem fliegenden Flugzeug), V. Heidelberg. Zeitschrift für Flugtechnik u. Motor Luftschiffahrt, vol. 10, nos. 21 and 22, Nov. 15 and 29, 1919, pp. 236-241 and 249-255, 22 figs. Accounts of experiments with airplanes in flight to determine effect of rudder and influence of its movements on the trim of the machine and on the balancing of moments. Results of experiments are presented with aid of tables and charts.

Sopwith

Sopwith Commercial and Sporting Types. Aerial Age, vol. 11, no. 7, April 26, 1920, pp. 219-220 and p. 232, 3 figs. General description of "Dove," "Gnu," "Grasshopper" and "Wallaby."

Speed at High Altitudes

Factors Involved in High Airplane Speed at Great Altitudes, H. C. Richardson. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 203-207, 7 figs. Study based on fundamental equations of flight and propeller data contained in reports of Nat. Advisory Committee for Aeronautics. It is concluded that under best conditions and assuming that data available could be proportionally reproduced at high altitudes, aeroplane could be designed to give speed of 260 m.p.h. at about 50,000 ft. altitude.

Strength

Note on an Empirical Formula for Aeroplane Strength, A. J. Sutton Pippard. Aeronautical Jl., vol. 24, no. 112, April 1920, pp. 204-205. Formula for load factor in terms of horsepower per 1000 lb. gross weight of aeroplane and overall length of aeroplane in feet. Table is given showing load factor for various types of aeroplanes both as computed from this formula and as actually determined.

Struts

Effect of Struts and Wires on the Speed of an Aeroplane (Einwirkung von Stielen und Kabeln auf die Geschwindigkeit eines Flugzeuges), V. Heidelberg. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 10, no. 20, Oct. 30, 1919, pp. 221-224, 6 figs. Measurements on a Fokker D VII with and without struts and wires are said to have shown that a strutted machine attains in horizontal flight only slightly more speed than the regular machine, but that its rate of climb is materially improved by the absence of struts.

Investigation of the Compressive Strength of Spruce Struts of Rectangular Cross Section and the Derivation of Formulas Suitable for Use in Airplane Design, James E. Boyd. Technologic Papers Bur. Standards, no. 152, April 19, 1920, 43 pp., 14 figs. It is concluded from experiments that Euler's formula gives accurate results in design of round-end spruce struts for values of L/r greater than 100 and may be used with little error for values between 80 and 100. Modification of Euler's formula for ultimate strength for round-end spruce struts, which corresponds to modulus of elasticity of 1,622.000 lb. per sq. in. is recommended, and also similar modifications of Rankine formula for short round-end spruce struts and for square-end struts.

Surveying and Mapping with

The Airplane in Surveying and Mapping, E. Lester Jones. Jl. Engrs. Club of St. Louis, vol. 4, no. 3, May-June 1919, pp. 218-232. Work of surveying by aeroplane is reviewed and opinion is expressed that aeroplane "can now furnish maps of a low order of accuracy so far as scale and position of features are concerned," and it "will undoubtedly be extensively used in unmapped areas in this and other countries in the very near future."

Transoceanic Service

The Possibilities of Development in the Construction of Aeroplanes and Dirigibles for Transoceanic Service (Ueber die Entwicklungsmöglichkeiten im Bau von Riesenflugzeugen und ozeantüchtigen Flugschiffen), F. Ernst Bielefeld. Motorwagen, vol. 22, no. 35, Dec. 20, 1919, pp. 680-685, 24 figs. Discussion of supporting plane section, load per square meter of supporting plane and construction in fabricated materials and metals of giant aeroplanes and ocean dirigibles, which writer predicts will be most generally employed in the future.

Wing Sections

Some Göttingen Tests on Thick Sections. Flight, vol. 12. no. 16, April 15, 1920, pp. 424-425, 8 figs. Tests on wing sections at Göttingen laboratory. Extracts from German Technical Reports.

[See also DIRECTION FINDERS; WIND TUNNELS.]

AIR COMPRESSORS

Lubrication of

Lubrication of Air Compressors, H. V. Conrad. Boiler Maker, vol. 20, no. 4, Apr. 1920,

Let's Use the Right Name

The name "Screw Machine" is no longer appropriate when applied to the modern Turret Lathe. It is seldom used for making screws—(automatics serve the purpose better for large quantities). Its field of work is as universal now as that of the engine lathe. Where bar work was almost the only product ten years ago, chucking work is now in the majority. Then, too, the modern Turret Lathe has in its design and construction, characteristics and power to handle tough forgings and alloy steel parts that would be superfluous for making screws.

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Peden Iron & Steel Company, Houston, Texas.

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A R. Williams Machinery Company, Ltd., Toronto, Winnipeg, Vancouver, St. John's.
Williams & Wilson, Ltd., Montreal.

ENGINEERING INDEX (Continued)

pp. 95-97. Satisfactory lubrication of air-compressor cylinders is said to be attained by securing (1) reduction of friction to a minimum, and (2) elimination of carbonization of oil as far as possible.

AIR PUMPS

Schell Hydraulic

The Removal of Air from Pumps and Suction Piping (Ueber Entlüftung von Pumpen und Saugleitungen). Braunkohle, vol. 18, no. 32, Nov. 8, 1919, pp. 420-423, 6 figs. Schell hydraulic air pump, which is said to possess few internal moving parts, and to require no attendance and no lubrication.

AIRCRAFT CONSTRUCTION MATERIALS

Timber, X-Ray Examination of

The Examination of Aircraft Timber by X-Rays, R. Knox and G. W. C. Kaye. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 60-65, 17 figs on 6 supp. plates. Method of examining aeroplane timber parts by X-rays developed by Aeronautical Inspection Department of Royal Air Force, England. It is said that no difficulty is experienced in detecting by that method concealed knots, resin pockets and grub holes, as well as excess or deficiency of glue in glued joints. It is added that in almost all instances fluorescent-screen examination suffices.

AIRSHIPS

Rigid Construction

New Type of Rigid Airship. Aeronautics, vol. 18, no. 339, April 15, 1920, p. 318. Type designed by Aerocruiser Co. of America. Structure is described as that of thick inverted "U." It is claimed that channel formation lessens resistance, thereby materially assisting in clearing through air.

Rigid Airships and Their Development, Alan Anderson. Aeronautical Jl., vol. 24, no. 112, April 1920, pp. 143-171 and discussion pp. 171-184, 20 figs. Details of construction of British types are outlined and problems of mooring, water recovery, and passenger accommodation are discussed, specially in regard to their bearing on structure and performance. Reliability of airship flying is concluded from official reports stating that during ten months of 1918 prior to armistice, proportion of days upon which airships carried out their flights was 97 per cent, a record which was obtained before the problem of mooring rigid airships had been solved.

Rigid Airship Construction, A. E. Rankin. Flight, vol. 12, no. 16, April 15, 1920, pp. 417-418, 6 figs. Type of bracing is suggested in which only five rivets are used instead of 12 rivets used in conventional type.

[See also AEROPLANES, Transoceanic Service.]

ALCOHOL

By-Product of Coal Distillation

Alcohol—A New By-Product of Coal Distillation (L'alcool, nouveau sous-produit de distillation de la houille), E. de Loisy. Revue de Métallurgie, vol. 17, no. 2, Feb. 1920, pp. 56-62. Process at Skinningrove Works, England. Cold charcoal absorbs ethylene from gases and gives it off when heated.

Alcohol from By-Product Gas. Gas Age, vol. 45, no. 7, Apr. 10, 1920, pp. 294-295. It is reported that motor fuel prospects in England have been brightened by the Skinningrove experiments converting ethylene into alcohol.

Motor Fuel

Alcohol As Fuel—I. Automobile Engr., vol. 10, no. 137, April 1920, pp. 157-160, 5 figs. Survey of chemical and physical properties of alcohol which determine its adaptability as motor fuel.

ALLOY STEELS

Coefficient of Expansion

The Coefficient of Expansion of Alloy Steels, John A. Mathews. Min. & Metallurgy, no. 158, section 8, Feb. 1920, 4 pp. Measurements were effected for various alloy steels at temperature range from 25 to 100 deg. cent. Values obtained ranged from 11.37 to 12.76 parts per million per deg. cent.

[See also STEEL, HIGH-SPEED.]

ALLOYS

Electric Production of

The Electrical Production of Alloys, Ralph M. Major. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no, 33, pp. 441-447, 2 figs. Account of producing alloys in two Héroult furnaces having different electrode regulating equipment, also discussion of general conditions of electric melting as compared with any other process of producing alloys. Manufacture and properties of Nichrome. Kromore, Mangaloy, Climax, and Inbar, are included.

Manganese-Gold

Manganese-Gold Alloys (Die Legierungen des Mangans mit Gold), L. Hahn and S. Kyropoulos. Zeitschrift für anorganische und allgemeine Chemie, vol. 95, no. 1-2, May 5, 1916, pp. 105-114, 2 figs. Results of experiments are given and compared with those of N. Parravano (Gazz. chim. Ital. 45 I, 1915, p. 293). Notes on composition of the résidue of gold-manganese alloys not soluble in acids as compared with that of the original alloys.

[See also ALUMINUM ALLOYS; MAGNESIUM ALLOYS; TIN ALLOYS.]

ALUMINUM

British Foundry Practice

British Aluminum Foundry Practice—II. Metal Industry, (N. Y.), vol. 18, no. 5, May 1920, pp. 221-224. From booklet of British Aluminum Co., Ltd., London.

Castings, Hard Spots in

Investigate Hard Spots in Aluminum, Robert J. Anderson and Julian H. Capps. Foundry, vol. 48, no. 9, May 1, 1920, pp. 337-342, 23 figs. Investigations at Bur. of Mines are said to have disclosed that hard spots in aluminum-alloy sand castings are caused by metallic and non-metallic inclusions. Metallic inclusions are said to be due to admixtures of iron, and non-metallic are attributed to carelessness.

Protective Coating for

Protective Coating for Aluminum (Brünieren von Aluminium), L von Grotthuss, Metall u. Erz., vol. 17, no. 2, Jan. 22, 1920, pp. 39-40, 7 figs. Description of an electrolytic process for giving to aluminum a durable brown coating which is proof against action of city and sea water, by the use of a molybdenum solution.

Wastes

A Method of Melting Wastes from Aluminum or Aluminous Alloys (Verfahren zum Zusammenschmelzen von Abfällen aus Aluminium oder aluminiumreichen Legierungen). Metall-Technik, vol. 45, no. 43-44, Nov. 5, 1919, p. 172. As results of experiments, writer recommends use of fluorides of heavy metals either alone or together with salts of the light metals. Those especially recommended are fluorides of zinc, copper, nickel and their double salts or mixture with fluoride of potassium.

ALUMINUM ALLOYS

Unsound Castings

Blowholes, Porosity, and Unsoundness in Aluminum-Alloy Castings, Robert J. Anderson. Dept. Interior, Bur. Mines, no. 241, 34 pp., 16 figs. It is concluded from results of experimental work, survey of experience of various foundries and examination of current literature, that: (1) Number of blowholes present is directly proportional to pouring temperature, (2) unsoundness varies with temperature to which charge is heated, the higher the temperature the more unsound being the resultant castings, and (3) unsoundness is function of length of time of melting, the longer any melt is held in furnace the more unsound being the castings, irrespective of temperature of heating and pouring temperature.

Uses

Increasing Use of Alloyed Aluminum as an Engineering Material—I. G. M. Rollason. Indus. Management, vol. 59, no. 5, May 1920, pp. 387-390, 9 figs. Properties of aluminum and aluminum alloys are given, and their recent uses are pointed out, particularly in automobile industry. Paper read before New York Section, Am. Soc. M. E.

AMMONIA

Synthesis of

Direct Synthesis of Ammonia by Catalysis Under Pressure (Contribution a l'étude de la synthèse directe de l'ammoniac par catalyse sous pression), Marcel Guichard. Bulletin de la Société d'Encouragement pour l'Industrie National, vol. 132, no. 1, Jan.-Feb. 1920, pp. 71-102, 22 figs. Over 400 catalyzers were experimentally studied. From data obtained and analytical consideration, gaseous cycle is formulated for determining best conditions of industrial synthesis of ammonia.

Vapor Pressure of

Vapor Pressure of Ammonia, Carl S. Cragoe, Cyril H. Meyers and Cyril S. Taylor. Sci. Papers Bur. Standards, no. 369, April 10, 1920, 35 pp., 7 figs. Apparatus and procedure employed in present measurements throughout temperature interval —78 to +70 deg. cent. Equations are developed for expressing vapor pressure of ammonia in range from —80 to +70 deg. cent.

AMPLIFIERS

Thermionic Inter-Valve Resistance Couplings

An Amplifier Employing Thermionic Inter-Valve Resistance Couplings, John Scott-Taggart. Elec. Rev. (Lond.), vol. 86, no. 2214, Apr. 30, 1920, pp. 549-550, 1 fig. It is proposed to use in place of ordinary conductors of high impedance a conductive path between cathode and anode. Application of arrangement to reception of wireless signals is explained.

ANEMOMETERS

Variation in Readings

Variation Produced by Inclination of Wind in the Readings of Robinson and Richard Anemometers (Sur la variation des indications des anémomètres Robinson et Richard en fonction de l'inclinaison du vent), C. E. Brazier. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 10, March 8, 1920, pp. 610-612. Results of experiments made at aerodynamic laboratory.

APPRENTICES, TRAINING OF

Willys-Overland System

Successful Substitute for Apprenticeship. Machy. (N. Y.), vol. 26, no. 8, Apr. 1920, pp. 746-748, 3 figs. System of labor-training developed by Willys-Overland Co., Toledo, Ohio, which keeps the "improvers," as men taking course of training are called, engaged upon regular lines of production work. How system is applied.

ARCHES

Design

Direct Determination of the Moment Influence Lines of the Fixed-Ended Arch (Direkte Ermittlung der Momenteneinflusslinien des Eingespannten Bogens), Josef Vincenz. Armierter Beton, vol. 12, no. 12, Dec. 1919, pp. 309-313, 4 figs. Account of what is said to be a simpler and more reliable method with which same result as with customary graphic method can be reached by the drawing of a single funicular polygon with corresponding elastic loads.

ARMY SUPPLY BASES

Philadelphia

Equipment of Army Supply Base at Philadelphia. Elec. Rev. (Chicago), vol. 76, no. 18, May 1, 1920, pp. 715-718, 8 figs. Electrical equipment of piers and warehouses to be used as loading station. Includes electrically operated cranes, electric trucks for moving traffic and electrically operated elevators.

ASPHALT

Sources of

The Lake Asphalt Industry, J. Strother Miller. Chem. & Metallurgical Eng., vol. 22, no. 16, Apr. 21, 1920, pp. 749-754, 8 figs. Description of most important sources of natural asphalt, Trinidad Lake and Bermudez Lake; and refining and fluxing. Ultra-microscope is said to show presence of colloidal clay particles. Review of theory of colloidal state.

AUTOMOBILE ENGINES

Cylinders

Accelerating Cylinder Production. Foundry, vol. 48, no. 345, Apr. 15, 1920, pp. 311-318, 15 figs. Details of foundry of the Nash Motor Co. in Kenosha, Wis., which, it is said, produces all its own castings. Attention to minute detail and adoption of every mechanical aid to speed and accuracy have, it is claimed, increased output of automobile cylinders in this plant.

Air-Cooled Cylinders for Franklins. Am. Mach., vol. 52, no. 14, April 1, 1920, pp. 705-718, 58 figs. Method of machining engine cylinders for Franklin, Packard, Cadillac, Chandler and Peerless automobiles.

Design

Modern Tendencies in Engine Design, L. H. Pomeroy. Automotive Manufacturer, vol. 62, no. 1, Apr. 1920, pp. 13-16, 1 fig. Summary of attempts made to employ other fuels than gasoline, and of studies undertaken to determine crankcase lubricant dilution by gasoline and best materials for various engine parts. (Concluded.)

Pistons, Machining

Machining Automobile Engine Pistons, Ralph E. Flanders. Machy. (N. Y.), vol. 26, no. 8, Apr., 1920, pp. 710-713, 7 figs. Description of methods and tooling equipments used in quantity production of automobile-engine pistons.

~~Methods of~~ Making the Winton Piston, Fred H. Colvin. Am. Mach., vol. 52, no. 18, April 29, 1920, pp. 927-934, 27 figs. Practice in Winton, Franklin, White and Packard shops.

Making 21,000 Pistons a Day, Fred H. Colvin. Am. Mach., vol. 52, no. 16, April 15, 1920, pp. 819-828, 31 figs. Practice in Ford, Cadillac and Autocar shops.

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ENGINEERING INDEX (Continued)

Testing

Organization and Method in the Testing Laboratory, P. S. Tice. Automotive Industries, vol. 42, no. 19, May 6, 1920, pp. 1061-1063. System is suggested which aims at eliminating haphazard running of tests by keeping complete and adequate records. Reference is made to method employed in dynamometer laboratory of carbureter division of Stewart-Warner Speedometer Corp.

Waterproofing

Successfully Submerging a Gasoline Engine, Levin H. Campbell, Jr. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 251-253, 5 figs. Experiment conducted by Artillery Division of Ordnance Department. Details of waterproofing of Cadillac eight-cylinder engine used in self-propelled caterpillar mount Mark VII are given.

[See also SPARK PLUGS.]

AUTOMOBILE FUELS

Volatility, Measure of

A New Instrument for Measuring Vapour Tension, Harold Moore. Jl. Soc. Chem. Industry, vol. 39, no. 6, March 31, 1920, pp. 78T-80T, 4 figs. Apparatus consists of two tubes of about ¼-in. bore and about 800 mm. long connected to each other and to leveling bottle by means of Y-piece and thick-walled rubber tubing. In one of tubes small amount of motor fuel to be measured is introduced and its vapor pressure is computed by comparing scale readings in both tubes under suitable positions of leveling bottle.

[See also ALCOHOL; GASOLINE.]

AUTOMOBILES

All-Weather Top

An All-Weather Top for the Open Passenger Car, George J. Mercer. Automotive Industries, vol. 42, no. 20, May 13, 1920, pp. 1106-1108, 4 figs. General shape is different from conventional one in that rear stationary part is of victoria shape.

Alvis

The 10.7 h.p. Alvis Sporting Car. Autocar, vol. 44, no. 1279, April 24, 1920, pp. 751-754, 7 figs. Specifications: 10.7 hp., four cylinders, 65.8 x 110 mm. bore and stroke; valves in line on one side; engine and gear box carried separately; four-speed and reverse gear box; open propeller shaft: straight-tooth bevel final drive; semi-elliptic springs, front and rear.

Angus-Sanderson

The 14.2 h.p. Angus-Sanderson Chassis. Automobile Engr., vol. 10, no. 137, April 1920, pp. 139-144, 18 figs. Characteristics; Engine, four-cylinder monobloc rated at 14.2 h.p.; leather-faced cone clutch arranged in flywheel; three-speed gear box, semi-elliptical springs at front and cantilever springs at rear.

Ashton

The 10.5 h.p Ashton Chassis. Autocar, vol. 44, no. 1278, April 17, 1920, pp. 709-712, 9 figs. Specifications: 10.5 hp. Coventry Simplex engine, 66 mm. x 109.5 mm. bore and stroke; three-speed and reverse gear box, gears always in mesh, dog clutch change; bevel final drive, floating axle shafts; transverse spring suspension.

Benz

German Car Incorporates Unusual Technical Features. Automotive Industries, vol. 42, no. 19, May 6, 1920, pp. 1056-1057, 5 figs. Clutch brake, timing patterns, and wheel puller of Benz car, manufactured at Mannheim, Germany.

Body Design

Automobile Body Design, William Brewster. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 215-218, 5 figs. Such considerations are taken up as size of relative positions of seats and doors, position of extra tires, design of windshield and influence of weight upon design.

Fine Coachwork from British Shops in Lanchester. Automotive Manufacturer, vol. 62, no. 1, April 1920, pp. 10-12, 3 figs. Details of vee-fronted sedan called saloon body, on 40-hp. six-cylinder chassis.

Crown

The Crown "Magnetic" Car. Autocar, vol. 44, no. 1279, April 24, 1920, pp. 759-762, 10 figs. Specifications: Six cylinders, 102 x 140 mm. bore and stroke; overhead valves, forced lubrication, no clutch; electrical transmission: full-floating helical-toothed bevel rear axle; semi-elliptic springs.

Drag Link

Development of the Drag Link Results in Many Improvements, V. A. Davisson. Automotive Industries, vol. 42, no. 17, April 22, 1920, pp. 956-958, 9 figs. Developments are replacement of brazing by electric welding, adaptation of cap socket for heavier cars, and improvements of grease cup.

Drive Shafts

Electrically-Heated Tubing for Automobile Drive Shafts. Automotive Manufacturer, vol. 62, no. 1, April 1920, pp. 21-23, 3 figs. Method of heat-treating developed by Snead & Co. Electric current of low voltage and high amperage is employed to heat tubing by its own internal resistance.

Hub and Axle Standardization

Starting the Standardization of Hub and Axle Design, J. Edward Schipper. Automotive Industries, vol. 42, no. 18, April 29, 1920, pp. 993-996, 4 figs. How standardization may be handled is pointed out and reasons are given why problem should be attacked immediately.

Nash

The Nash Six-Cylinder 29.5 H. P. Car. Auto, vol. 25, no. 15, April 8, 1920, pp. 384-386, 7 figs. Distinguishing feature is said to be spring-loaded sleeve device concentric to hollow shackle pins, which is claimed to enable ordinary gear-oil to be used and to facilitate maintenance.

Plywood

Plywood and Its Uses in Automobile Construction, Armin Elmendorf. Jl. Soc. Automotive Engrs., vol. 6, no. 5, May 1920, pp. 299-306, 11 figs. Strength of various species of three-ply panels is given in tabular form and curves are presented showing deflection of plywood under various loads. Figures are included showing comparison strength of plywood with various metals and pulp boards.

Production

The Austin Motor Co., Ltd.—I. Machy (Lond.), vol. 16, no. 397, May 6, 1920, pp. 125-132, 11 figs. Practice of Austin Motor Co., Ltd., Birmingham, England.

Rear-Axle Drives

Direct Multiple-Speed Automobile Rear-Axle Drives, H. C. McBrair. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 258-264, 21 figs. Various American and foreign forms of rear-axle drives are illustrated, and relation of gear ratio to horsepower is discussed.

B

BARGES

Mississippi River

River Transportation in the Mississippi Valley, E. W. Schadek. Mech. Eng., vol. 42, no. 5, May 1920, pp. 270-272, 5 figs. Review of recent progress in construction of barges and tow-boats for river transportation, particularly in Mississippi River Section, and of provision made for their operation.

Steel, N. Y. Barge Canal

Steel Barges for the New York Barge Canal. Int. Mar. Eng., vol. 25, no. 5, May 1920, pp. 400-401, 3 figs. Dimensions: length inside fenders, 150 ft.; beam molded, 20 ft.; depth, 12 ft.; draft, light, aft, 30 ft.; displacement, light, 155 tons; deadweight cargo, 550 tons.

BEAMS

See GIRDERS.

BEARINGS

Design of

Scientific Design of Bearings (Étude scientifique des paliers), M. Strauven. Revue Universelle des Mines, vol. 5, no. 1, April 1, 1920, pp. 53-74, 19 figs. Reference is made to Reynolds theory which establishes that when two bearing surfaces which are strictly parallel are separated by layer of oil, it is impossible to make them support an external load without forcing out oil film. With this theory in view forms of bearing surfaces composed of parts inclined to direction of axle are suggested.

BEARINGS, BALL

Ball Cages

Influence of the Ball Cage of a Radial Ball Bearing (Einfluss des Kugelkäfigs beim Kugeltraglager (Ringlager), Ed. Müller. Werkstatts Technik, vol. 13, no. 19, Oct. 1, 1919, pp. 290-293, 8 figs. Discussion of certain designs of ball cages of standard radial bearings, and investigation of influence of cage construction on permissible load for radial bearing.

Manufacture

Ball-Bearing Manufacture — II. Machy. (Lond.), vol. 16, no. 397, May 6, 1920, pp. 133-137, 15 figs. Methods used by Hoffman Manufacturing Co., Ltd., for producing balls, races and cages.

BELTING

Belts and Tighteners

Belts and Belt Tighteners (Ueber Riemen und Spannrollen), C. Bender. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 10 and 11, March 6 and 13, 1920, pp. 227-230 and 254-257, 19 figs. Discussion of belting practice in America and Germany, with particular reference to the Taylor experiments and Dr. W. Stiel's book, **The Theory of Belt Drive.** Writer describes and gives examples of belt drive with free-swinging tightener pulley, which he claims has many excellent points and no great disadvantages.

BLAST FURNACES

Slag, Utilization of

The Schol Process for Production of Artificial Pumice Stone from Blast-Furnace Slag (Das Scholsche Verfahren zur Herstellung von Leichtsteinen aus Hochofenschlacke), A. Gutmann. Stahl u. Eisen, vol. 40, no. 10, March 4, 1920, pp. 326-331 and (discussion) pp. 331-332, 4 figs. Process patented by Schol under the name "thermosit." Details and illustrations of press employed, schematic production diagram, etc. Report of Blast Furnace Committee of Assn. German Iron Foundrymen.

BLASTING

See EXPLOSIVES.

BOILER FEEDWATER

Gas Removal from

The Removal of Gases from Boiler Feedwater (Ueber die Entgasung des Kesselspeisewassers), Ludwig Jung. Stahl u. Eisen, vol. 40, no. 10, March 4, 1920, pp. 321-326, 10 figs. Damaging effect of gaseous feedwater on boiler material is illustrated with photomicrographs, importance of gas-free feedwater is pointed out and measures for obtaining it are recommended.

The Removal of Gas from Boiler Water, Ludwig Jung. Eng. & Indus. Management, vol. 3, no. 13, March 25, 1920, pp. 393-396, 3 figs. Plant of mechanical type, constructed for treatment of 10,000 gal. of feedwater per hour after preparatory softening by means of Permutite process, is described. Translated from Zeitschrift des Vereines deutscher Ingenieure.

The Separation of Dissolved Gases from Water, J. R. McDermet. Mech. Eng., vol. 42, no. 5, May 1920, pp. 237-278, 6 figs. Process is outlined which consists of rapid injection of heated water into region of vacuum, and explosive boiling of it at expense of heat of liquid, with simultaneous recovery of heat liberated to vacuum by heat exchanger or condenser cooled by incoming water, preliminary to its heating.

BOILER FIRING

Low-Grade Coals

Burning Low-Grade Coals of the Southwest, W. M. Park. Elec. World, vol. 75, no. 17, April 24, 1920, pp. 947-948, 4 figs. Operating and test results obtained with chain-grate settings of different types. Recommendations for companies using fuels available. Analyses of several varieties of southwestern coals.

Oil-Fuel Installation

A Fuel-Oil Installation, H. A. Wilcox. Power Plant Eng., vol. 24, no. 10, May 15, 1920, pp. 501-506 and 527-531, 16 figs. Account of installing oil-burning equipment in boiler formerly operated with coal. Results of coal and oil tests.

[See also STOKERS, Conveyor-Feed Type.]

BOILER PLATE

Properties at High Temperatures

Tensile Properties of Boiler Plate at Elevated Temperatures, H. J. French. Min. & Metallurgy, No. 158, Section 15, Feb. 1920, 11 pp., 8 figs. Work done at Bureau of Standards for committee of Eng. Division, Nat. Research Council. Changes in strength, ductility and other properties, resulting from increase in temperature from 70 to 870 deg. fahr., were observed in both firebox and marine types of plates.

BRIDGES

Piers, Bascule-Bridge

Heavy Foundation Work for Bascule Bridge at Seattle, F. A. Rapp. Eng. News-Rec., vol. 84, no. 16, April 15, 1920, pp. 774-776, 3 figs. Twin massive concrete blocks 65 x 40 ft. in horizontal dimensions and over 20 ft. thick constitute substructure of each of two piers. Deep pile foundations were required on one side of channel while on other side foundation concrete rests directly upon firm material.

Piers, Pile and Concrete

Pile and Concrete Piers for Missouri River Bridge. Eng. News-Rec., vol. 84, no. 17, April 22, 1920, pp. 824-825, 3 figs. Construction of timber pile piers carrying two 300-ft. steel truss spans of railway bridge.

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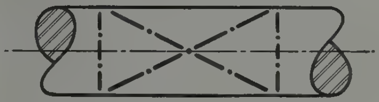

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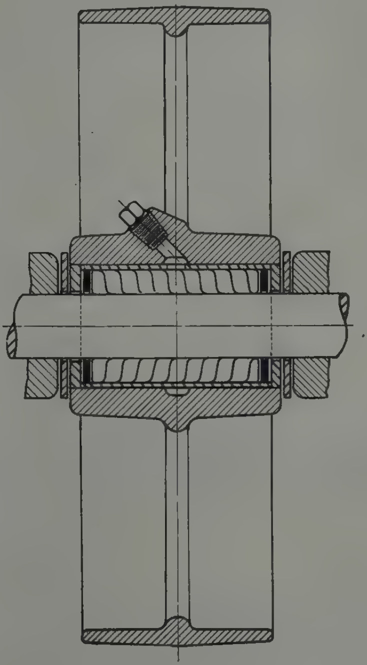

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E

ENGINEERING INDEX (Continued)

BRIDGES, CONCRETE

Load Distribution

Investigation of the Load Distribution on the Cross Beams in a Reinforced-Concrete Girder Bridge (Untersuchung über die Last-Verteilung von Querträgern bei einer Balkenbrücke aus Eisenbeton), F. Knorr. Armierter Beton, vol. 12, no. 12, Dec. 1919, pp. 299-308, 17 figs. Notes on calculation of load distribution, including general elasticity equations and their application; and comparison of calculation with the load test.

Springfield, Mass.

To Build Large Bridge Across the Connecticut at Springfield, C. M. Spofford. Eng. News-Rec., vol. 84, no. 17, April 22, 1920, pp. 817-818, 2 figs. Proposed new bridge is to consist of seven reinforced-concrete arch spans with total length of 1129 ft. between abutments and clear width of roadway of 60 ft. with sidewalks 10 ft. wide on each side.

BRIDGES, LIFT

Bascule, Seattle, Wash.

Three Double-Leaf Bascule Bridges at Seattle, Wash., F. A. Rapp. Eng. News-Rec., vol. 84, no. 15, April 8, 1920, pp. 718-722, 6 figs. Bridges are two-leaf structures of simple trunnion type and have live-load bearing near river edge of each trunnion pier, 13 ft. in front of trunnion. In closed position each leaf pivots on this bearing instead of on trunnion, so that counterweight acts with longer lever arm than it does in open position of bridge and uplift at tail of leaf is decreased.

Rolling Bascule

Advantages of Rolling Bascule Bridges, Walter P. Chapman. Contract Rec., vol. 34, no. 14, April 7, 1920, pp. 316-318, 6 figs. It is noted that rolling lift provides maximum lever arm and therefore permits use of more economical material for counterweight. It is stated that 300 bridges of this type are now in operation.

BRIDGES, RAILWAY

Rapid Construction

Southern Railway Rebuilds Chattanooga Bridge. Ry. Age, vol. 68, no. 15, Apr. 9, 1920, pp. 1141-1143, 6 figs. Account of project in rapid emergency bridge construction recently completed by Southern Railway at Chattanooga, Tenn., telling how work on foundations and superstructure was handled.

Reconstruction of

Extending the Life of the Niagara Gorge Arch. Ry. Age, vol. 68, no. 20, May 14, 1920, pp. 1393-1397, 8 figs. Overhauling of Grand Trunk Railway bridge to carry loads 62 per cent greater than those for which it was designed 22 years ago.

Kenova Bridge End Span Erection. Public Works, vol. 48, no. 15, April 24, 1920, pp. 345-347, 2 figs. Two single-track 298-ft. spans, 100 ft. above water level, were replaced by double-track spans on substructure without interrupting traffic.

Wooden

Report of Committee VII—On Wooden Bridges and Trestles. Bul. Am. Ry. Eng. Assn., vol. 21, no. 225, March 1920, pp. 303-362. Specifications and classification and grading rules for lumber and timber to be used in construction and maintenance of Way Department of railroads.

[See also BRIDGES, LIFT, Rolling Bascule.]

BRIDGES, SUSPENSION

Wind Load

Calculation of Extent to Which Cable in Suspension Bridges Takes Up Wind Load (Die Entlastung des Windverbandes bei Hängebrücken durch die Kabel). N. Royen. Der Eisenbau, vol. 10, no. 11, Nov., 1919, pp. 239-243, 3 figs. Writer gives what he describes as a simple and exact method for this calculation.

BRIDGES, SWING

Repairing

A Novel Method of Repairing a Swing Bridge, Herbert C. Meith. Proc. Am. Soc. Civil Engrs., vol. 46, no. 2, Feb. 1920, pp. 305-331, 11 figs. partly on 2 supp. plates. Method used to renew chords of swing span of Washington Bridge over Housatonic River without impeding traffic. System of temporary adjustable timber members was devised to carry bottom-chord stresses while permanent chords were being renewed, allowing free use of bridge for half width of roadway at all times and also permitting span to be opened as required for river traffic.

BRIDGES, WOODEN

See BRIDGES, RAILWAY, Wooden.

BUILDING CONSTRUCTION

Economical Speed

Economical Speed in Building, Angus B. MacMillan. Indus. Management, vol. 59, no. 5, May 1920, pp. 392-394, 3 figs. Figures are given which show for typical building how increasing cost of forms progresses as building period is successively shortened, and how at the same time overhead costs decrease with speed. Minimum is reached at point between most rapid and most leisurely construction.

Estimates in

The Expense of Estimating, Henry K. Holsman. Am. Architect, vol. 127, no. 2312, April 14, 1920, pp. 475-477. It is stated that present methods followed in estimating involve considerable duplication of effort. It is suggested that quantity survey should be furnished by owner with plans and specifications. This, it is claimed, would eliminate needless expense and insure uniform basis for bidding.

Termite-Proof

Termite Proof Building Construction in Formosa, Masamitsu Oshima. Eng. World, vol. 16, no. 7, May 1920, pp. 411-415, 8 figs. Treatment given to timbers used in building construction and cement layer spread over buildings in order to protect them against termite (Coptotermes formosanus) which is widely distributed throughout Formosa.

BUSES

See STREET RAILWAYS, Street Cars vs. Omnibuses.

C

CABLES, ELECTRIC

Characteristics of

Characteristics of Three-Phase Lines for Harmonics of Third Order (Constantes caractéristiques des lignes triphasées pour les harmoniques 3), R. Swyngedauw. Revue générale de l'Electricité, vol. 7, nos. 15 & 16, April 10 and April 17, 1920, pp. 483-492 and pp. 515-526, 6 figs. Formulæ for electrical characteristics of long armored cables in underground lines. Phenomena in lines not exceeding 20 or 30 km. can well be studied, it is stated, neglecting effective resistance and reactance and taking into consideration only persistance and susceptance. Experimental measurements of reactance, impedance and resistance of cables 4 to 10 km. long.

Combined Telephone and Telegraph

Combined Telephone and Telegraph Cables: Important Trials, A. H. Roberts and W. J. Hilyer. Post Office Elec. Engrs. Jl., vol. 13, part 1, April 1920, pp. 29-48, 13 figs. Tests made on 76-pair 40-lb. balanced telephone cable in order to ascertain practicability of providing combined telephone and telegraph cables between London and Manchester. Over loop circuit 186 miles in length, speed of 150 words per minute duplex was obtained with 40 volts on differential system and 60 volts on bridge system; induction on loaded telephone pairs was less from differential than from bridge Wheatstone working. Other results are mentioned.

Dielectric Losses

Energy Losses in Dielectric of Industrial Cables (Sur la perte d'énergie dans le diélectrique des câbles industriels), M. Rennesson. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 10, March 8, 1920, pp. 587-589. Account of experiments conducted in order to test conclusions reported by M. Swyngedauw in Comptes rendus, vol. 168, p. 230, where he states that losses decrease when temperature of cable increases.

CAR WHEELS

Chilled-Iron, Manufacture

Manufacturing Chilled Iron Car Wheels—II and III. H. E. Diller. Foundry, vol. 48, nos. 345 and 346, April 15 and May 1, 1920, pp. 304-310, 16 figs., and pp. 353-359, 13 figs. Description of cupola practice and methods of core room. Description of molding methods.

CARS, FREIGHT

Inspection of

The Inspection of Freight Equipment, L. K. Sillcox. Ry. Mech. Engr., vol. 94, no. 5, May 1920, pp. 285-288. Air brakes and foundation brake rigging; estimated braking power; defects of arch bars and trucks. Fifth article.

Repairing of

Freight Car Repairs on the E. P. & S. W., A. M. Dow. Ry. Mech. Engr., vol. 94, no. 5, May 1920, pp. 281-284, 11 figs. Outline of policies followed by El Paso & Southwestern Railway.

CAST IRON

Iron Carbide in

The Solubility and Stability of Iron Carbide in Cast Iron, J. A. Holden. Foundry Trade Jl. & Pattern Maker, vol. 22, no. 220, April 1920, pp. 270-271, 3 figs. Experiments are related and it is concluded from them that carbide is stable while it is in solid solution even in presence of considerable percentage of silicon.

CATALYSIS

Nickel Catalyzer

A New Type of Catalyzer for Hydrogenation, W. D. Richardson. Chem. & Metallurgical Eng., vol. 22, no. 17, April 28, 1920, pp. 793-796. Method of preparing finely divided nickel catalyzer by mechanical grinding.

CEMENT GUN

Applications

Construction Work by Cement Gun Methods, Arthur J. White. Proc. Engrs. Soc. Western Pennsylvania, vol. 36, no. 2, Mar. 1920, pp. 109-130 and (discussion) pp. 131-144, 13 figs. Examples are presented of structures covered with gunite. Among these are rapid transit bridge, Long Island, N. Y., roof of power plant of Ford Motor Co., Detroit, and tanks of Peoples Gas, Light & Coke Co., Chicago. Advantages of covering steel structures with gunite are enumerated.

CEMENT MANUFACTURE

Kiln Insulation

Cement and Lime Kiln Insulation. K. A. Grogan. Cement, Mill & Quarry, vol. 16, no. 8, April 20, 1920, pp. 27-32, 16 figs. Advantages of insulating cement and lime kiln are pointed out, and curves are shown comparing amount of heat lost through kiln crown when insulated and uninsulated. Sil-O-Cel insulating brick is recommended as "highly effective for all classes of insulating service."

CENTRAL STATIONS

Electric-Furnace Loads

Electric Furnace Power from the Standpoint of the Central Station, E. A. Wilcox. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 38, pp. 589-609, 2 figs. Questions relative to operation of electric furnaces from central power station are discussed, such as comparison with other kinds of power station loads, methods of charging for power, off-peak service (particularly to steel castings plants), continuous vs. intermittent service, power rate schedules and different systems of furnaces and their demands on power supply.

The Electric-Arc Melting Furnace and the Central Station Electric Company, Augustus C. Smith. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 43, pp. 701-709, 7 figs. Effect electric-arc melting furnace has on power supply, particularly surges on line because of careless handling of furnace during melting-down period. Experience is quoted of abnormal requirements of number of furnaces and it is pointed out how economical operation may be effected by careful working.

Large, Industrial Need of

Urgent Need of Super-Power Developments, C. F. Lacombe. Elec. World, vol. 75, no. 20, May 15, 1920, pp. 1128-1131, 1 fig. It is said that increased industrial production and shortage of power over large manufacturing districts call for immediate development of great power projects and elimination of small steam plants.

CHUCKS

Magnetic

The Magnetic Chuck, Its Design and Varied Uses, J. H. Moore. Can. Machy., vol. 23, nos. 16 & 17, April 15 and 22, 1920, pp. 369-372, 10 figs., and pp. 394-399, 12 figs. Fundamental principles of design, together with varied uses of magnetic chuck are discussed.

CIRCUIT BREAKERS

Automatic

Automatic Circuit-Breakers (Dispositifs automatiques de sectionnement des lignes électriques), P. Charpentier. Revue générale de l'Électricité, vol. 7, no. 15, Apr. 10, 1920, pp. 493-497, 16 figs. Oil three-pole circuit breaker built by Maljournal and Bourron Electric Works.

CITY PLANNING

See TERMINALS, RAILWAY, Relation to City Plan.

COAL

Spontaneous Ignition

A Method of Determining the Relative Temperatures of Spontaneous Ignition of Solid Fuels, F. S. Sinnatt and Burrows Moore. Jl.

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This story, which comes from the Colonial Biscuit Co., Philadelphia, Pa., has an equal wherever Robbins Portable Conveyors and Pilers are used. This equipment handles bales, barrels, boxes, bags, etc., weighing up to 700 lbs., through any arrangement of space.

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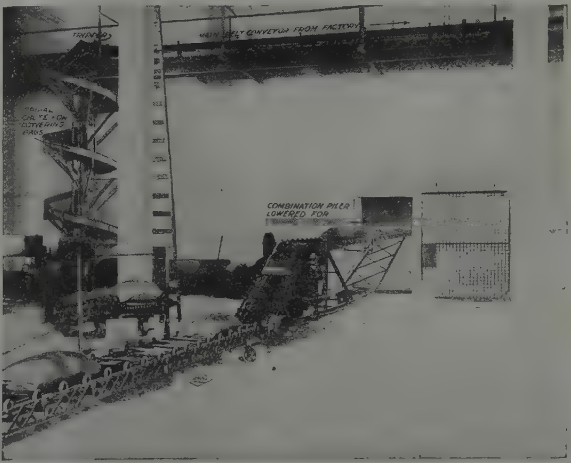
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MAIN BELT CONVEYOR FROM FACTORY
SPIRAL CHUTE FOR LOWERING BAGS
COMBINATION PILER LOWERED FOR

Illustrating building to building, floor to floor, and warehouse to freight car conveying

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"Nothing Succeeds Like Service"

Soc. Chem. Industry, vol. 39, no. 6, March 31, 1920, pp. 72T-78T, 8 figs. Experiments planned (1) to determine relative tendencies to spontaneous ignition in oxygen of certain finely powdered fuels; (2) to examine influence of degree of fineness of particles on temperature recorded; and (3) to examine influence of volatile matter upon temperature recorded. Apparatus consisted of heavy cast-iron vessel in which enclosed nickel crucible could be raised to any desired temperature.

COAL BREAKERS

Pennsylvania

Price-Pancoast Breaker Relies on Gravity to Do Much of the Work, Dever C. Ashmead. Coal Age, vol. 17, no. 18, April 29, 1920, pp. 841-844, 5 figs. Installation of coal company in Pennsylvania where only two conveyors are installed, one for handling condemned coal and one for handling rock. Coal is conveyed by gravity.

COAL HANDLING

Car-Dump Coal Pier

Design and Operation of Modern Car-Dump Coal Pier. Eng. News-Rec., vol. 84, no. 16, April 15, 1920, pp. 759-762, 8 figs. Coal pier of C. R. R. of N. J., at Jersey City terminal, built to handle 400 cars per day, and equipped with two independently operated cardumpers. Reinforced-concrete girder trestles, it is stated, have proved more economical than steel.

Loading Machine

Coal Loader Based on a New Principle. Coal Age, vol. 17, no. 19, May 6, 1920, pp. 900-902, 3 figs. Joy loading machine. Machine is electrically driven and is 29½ ft. long, 5 ft. wide and 5 ft. high. Gathering mechanism consists of pair of gear fingers, the initial movement of which is forward into coal, after which there is raking motion across coal face, then rearward movement toward loading conveyor, then return to starting position.

Pumping Installation

Pumping Coal, George Frederick Zimmer. Eng. & Indus. Management, vol. 3, no. 13, March 25, 1920, pp. 405-406, 1 fig. Installation at Hammersmith Power Station, England. Coal is discharged into large overhead steel copper which is covered with grating having mesh of five inches. Coal passes from copper through weighing device into tank where it is mixed with water. From tank it is sucked into inlet of 7-in. Gwynne motor-driven centrifugal sludge pump, delivery pipe of which is connected with 8-in. main pipe line 1,750 ft. long. Pipe line has branches and by ordinary sluice valves stream of coal and water can be directed into any one of delivery tanks.

[See also COKE HANDLING, Gas Works Equipment.]

COAL MINES

Exhaust-Steam Utilization in

Cutting Power Costs at an Anthracite Mine by Utilizing Exhaust Steam, Dever C. Ashmead. Coal Age, vol. 17, no. 20, May 13, 1920, pp. 983-986, 7 figs. Experience of Price-Pancoast Coal Co., Scranton, Pennsylvania, with low-pressure turbines utilizing exhaust steam from several engines.

Management Methods

Management Methods That Will Secure Results in Mine Construction, Charles Gottschalk. Coal Age, vol. 17, no. 20, May 13, 1920, pp. 987-989. Organization required for simultaneously carrying on various operations involved in constructing surface layout and in developing underground nucleus for coal mine of large capacity.

COAL MINING

Coal-Cutting Equipment

Approved Explosion-Proof Coal-Cutting Equipment, L. C. Ilsey and E. J. Gleim. Dept. Interior, Bur. Mines, bulletin 78, 1920, 53 pp., 35 figs. Gives Bureau's schedule and shows its application to testing of commercial apparatus. Describes electrical apparatus that has been tested and approved under this schedule and also tests on which approvals were based.

Electric Power in

Using Electric Power for Mining Coal. Black Diamond, vol. 64, no. 17, April 24, 1920, pp. 462-465, 7 figs. Details of Kentucky and West Virginia Power Company's plant which supplies power to practically all of coal mines in Logan district and to most of those in Mingo County, West Virginia and Pike and Perry Counties, Kentucky.

Shaft Layout

Mine Layout Arranged for Large Tonnage and Minimum Handling Cost, James R. Elliott. Coal Age, vol. 17, no. 20, May 13, 1920, pp. 978-979, 3 figs. Shaft layout at Mather Collieries, Greene County, Pennsylvania.

COAL STORAGE

Economy and Advantages

Storage of Coal—An Engineers' Problem. Indus. Management, vol. 59, no. 5, May 1920, pp. 399-408, 3 figs. Symposium by prominent engineers. Economy of coal storage, its use for stabilizing coal industry, and its advantages to the mining industry, are discussed.

COAL TAR

Progress of Industry

The Modern Technique of the Coal Tar Industry (La technique moderne de l'industrie des goudrons de houille), M. C. Berthelot. Revue de Métallurgie, vol. 17, no. 2, Feb, 1920, pp. 63-92, 14 figs. Recent progress of coal-tar industry is surveyed. (To be continued.)

COAL TIPPLES

Ohio Plant

Plant and Tipple of the Allied Coal Co. Coal Industry, vol. 3, no. 4, April 1920, pp. 177-180, 3 figs. Account of stripping operation at Sonora, Muskingum County, Ohio. Tipple is designed to handle 250 tons of coal per hour.

COKE

By-Product, Superiority of

By-Product Coke and By-Products of Coal, T. E. Pierce. Blast Furnace & Steel Plant, vol. 8, no. 5, May 1920, pp. 283-287. Survey of development of by-product coke ovens. Tests at University of Illinois and at laboratories of American Radiator Co. are said to have established superiority of by-product coke over other cokes.

COKE HANDLING

Gas Works Equipment

Charlestown Coal Equipment, Walter V. Turner. Gas. Rec., vol. 17, no. 7, Apr. 14, 1920, pp. 11-14, 5 figs. Mechanical apparatus for handling coal and coke in Massachusetts gas plant.

COKE PLANTS

By-Product

By-Products Coke, J. F. Springer. Sci. Am. Monthly, vol. 1, no. 5, May 1920, pp. 422-425, 6 figs. Plant near Jersey City, with 165 ovens arranged in single row, divided into three sections of 55 ovens each.

COLLOIDS

Research Work on

Recent Work on Colloids, R. S. Willows. Chem. Age, vol. 2, no. 34, Feb. 7, 1920, pp. 148-149. Reference is made to result obtained by Bragg's method of studying crystal structure, with fine particles having very fully developed crystalline structure, to investigations relative to separation of minerals by frothing, and to studies of colloids undertaken with a view to develop theory of lubrication. Paper read before Chemical Section of Manchester Literary and Philosophical Society.

COLUMNS

Reinforced-Concrete

Permissible Loading of Columns with Spiral Reinforcement (Zulässige Belastung Spiralarmierter Säulen), H. Fuchs. Armierter Beton, vol. 12, no. 12, Dec., 1919, pp. 318-320. Presents table submitted by the German Committee for Reinforced Concrete with accompanying explanations.

CONCRETE

Action of Water on

Flood Prevention Works at Troon, Ayrshire, and the Action of Sea Water on Concrete, E. R. Matthews. Surveyor, vol. 57, no. 1474, April 16, 1920, pp. 329--332, 5 figs. It is concluded from tests performed in connection with flood-prevention works that a 3 :1½ :1 mixture in air with granite and granite dust aggregate has very little higher compressive strength at end of three months after mixing than where river gravel and sand aggregate is used. It is also concluded that granite concrete should be used whenever possible for submerged works and broken brick should never be used as an aggregate. For tidal structures where concrete is alternately in air and in sea water, gravel concrete is considered as serviceable as granite concrete, but for structures permanently submerged in sea water latter mixture is recommended.

The Destruction of Concrete Structures by Leakage Water (Ueber Zerstörungen von Betonbauwerken durch Sickerwässer), H. Helbing and H. Bach. Zentralblatt der Bauverwaltung, vol. 39, no. 87, Oct. 25,1919, pp. 520-522, 8 figs. Various examples of such destruction are cited. Writers believe in some cases it is possible to mitigate danger of chemical destruction of concrete by use of trass as addition to cement, as well as blast-furnace cement instead of portland cement; but doubt whether this would entirely eliminate danger. When nature of construction base or of ground- and leakage-water conditions is doubtful, it is advised to avoid concrete construction and substitute brick masonry laid in a rich cement mortar to which trass is added.

Proportioning

Proportioning Concrete From Study of the Aggregate, G. M. Williams. Eng. News-Rec., vol. 84, no. 17, April 22, 1920, pp. 811-813. Comment on paper Mixing Concrete by Surface-Areas on Actual Work, by R. B. Young, in Eng. News-Rec., Jan. 1, 1920, and reply by Mr. Young to one of the criticisms.

CONCRETE CONSTRUCTION

Pressure of Concrete on Forms

Pressure of Concrete on Forms Measured in Tests, E. B. Smith. Eng. News-Rec., vol. 84, no. 14, April 1, 1920, pp. 665-667, 4 figs. Account of tests performed in laboratory of research section of Bureau of Public Roads at Arlington Experimental Farm near Washington. It was found that maximum pressure was increased as consistency of concrete was made drier within limits of workability. Richness of mix was also found to affect maximum pressure obtained, the richer the mix the greater being the maximum pressure. Empirical formula is given for computing lateral pressures.

CONCRETE CONSTRUCTION, REINFORCED

Oval Basin

Calculations for an Oval Receiving Basin (Berechnung eines ovalen Sammelbehälter), Carl Ritter. Armierter Beton, vol. 12, no. 12, Dec., 1919, pp. 313-315, 4 figs. Formula derived by writer while designing receiving basin of oval shape for pump house of large plant.

CONCRETING

See CEMENT GUN.

COPPER

Cold-Rolling

The Influence of Cold Rolling on the Physical Properties of Copper, F. Johnson. Metal Industry (Lond.), vol. 16, no. 16, April 16, 1920, pp. 307-314, 7 figs. Tensile, elongation and scleroscope tests on strip-copper specimens, showed that tenacity and hardness increased by application of cold work, except at certain stages where over certain ranges they remained constant. Over these ranges specific gravity either decreased or remains constant and elastic limit increases.

Effect of Hydrogen on

Some Notes on the Effects of Hydrogen on Copper, W. C. Hothersall and E. L. Rhead. Metal Industry (Lond.) vol. 16, no. 15, April 9, 1920, pp. 293-296, 8 figs. Experimental investigation of effect produced by passage of hydrogen through molten copper on properties of copper when cast. General conclusion is formed that copper treated in molten state with hydrogen will, under suitable conditions, cast sound, while copper which has not been treated with hydrogen but has been deoxidized by carbon will not cast sound under same conditions of casting; but copper treated with hydrogen is liable to pipe badly on casting unless comparatively large amount of arsenic is present. Paper read before Inst. of Metals.

Intercrystalline Brittleness

A Peculiar Type of Intercrystalline Brittleness of Copper, Henry S. Rawdon and S. C. Langdon. Min. & Metallurgy, No. 158, Section 10, Feb. 1920, 4 pp., 3 figs. Concerning embrittlement of copper when heated in molten salt bath while being cleaned or softened. Embrittlement is explained by electrolytic formation of metallic sodium which alloys immediately with copper.

COST ACCOUNTING

Routing and Cost Keeping

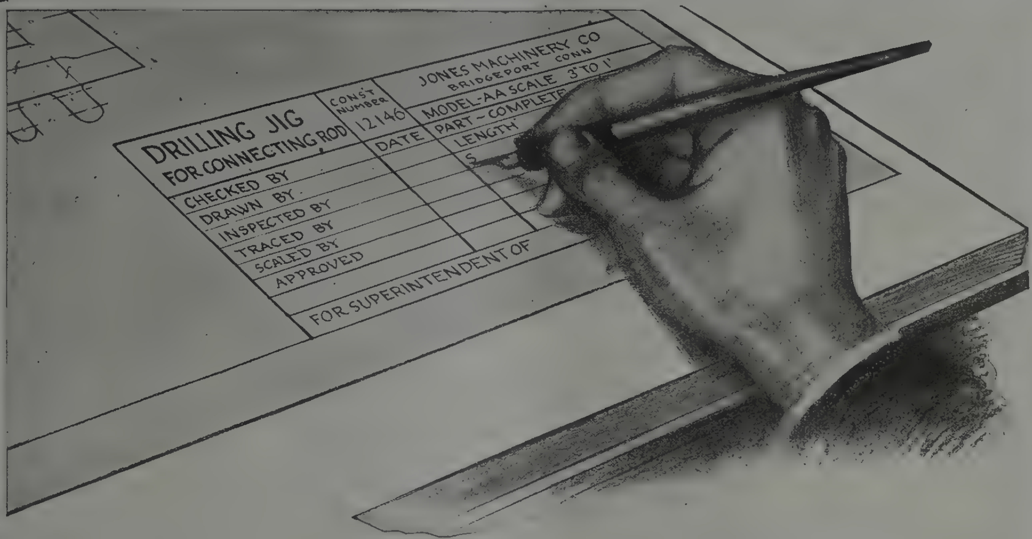
Controlling Production and Keeping Costs in a Broaching Tool Plant, H. R. Simonds. Iron Trade Rev., vol. 66, no. 10, Mar. 4, 1920, pp. 697-702, 16 figs. Plan of routing and cost keeping followed at plant of J. N. Lapointe Co., New London, Conn. Records enable executives to know at once status of job in relation to schedule. Forms used are illustrated.

Handling Plant Appropriations, James J. Zimmerman. Iron Trade Rev., vol. 66, no. 9, Feb 26, 1920, pp. 634-637, 8 figs. System is outlined for recording construction statistics so that status of any particular work, for which appropriation has been made, can be had at any time.

COSTS

Price Changes

Quantitative Analysis of All Factors That Affect Average Prices and a Formula for Predicting Price Changes, Halbert P. Gillette. Eng. & Contracting, vol. 53, no. 14, April 7, 1920, pp.



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107-8

ENGINEERING INDEX (Continued)

381-402, 6 figs. It is concluded from study of economic situation based on laws of economics and statement of conditions as reported by Department of Labor that "the level of commodity prices and wages will not descend permanently below 1¾ times the pre-war level for many years to come."

CRANES

Bridge Storage

Progress in the Construction of Bridge Storage Cranes at Locomotive Coaling Plants in Austria (Konstruktive Neuerungen an Greiferkranen bei Lokomotivbekohlungsanlagen in Oesterreich), Vladislav Sykora. Elektrotechnik u. Maschinenbau, vol. 38, no. 9, Feb. 29, 1920, pp. 94-100, 17 figs. Details and illustrations of various new devices and systems with electrical equipment, developed by the Austrian Brown-Boveri Co., the A. E. G. Union Electrical Co., Vienna, etc.

Floating

The Latest Developments in Floating Cranes (Die neueste Entwicklung des Schwimmkrans), H. Wintermeyer. Schiffbau, vol. 21, no. 15, Mar. 3, 1920, pp. 467-470, 5 figs. Notes on floating cranes with jibs of variable radius, with trolleys on stationary bridges, and with jibs revolving around vertical axis.

Hammerhead

The Largest Fitting-Out Crane in America. Int. Mar. Eng., vol. 25, no. 5, May 1920, pp. 412-416, 12 figs. Details of 350-ton hammerhead crane erected on fitting-out pier of Loney Island Navy Yard. Overall height of crane is over 245 ft. Its cost above foundations was $875,000.

Shipyard

A New Type of Shipyard Crane. Shipbuilding & Shipping Rec., vol. 15, no. 17, Apr. 22, 1920, pp. 544-546, 3 figs. Type installed at Gothenburg Shipyard of Lindholmen Shipbuilding & Eng. Co. It is composed of stationary main structure and two swinging arms, the former consisting of two lattice-work masts placed about 15 ft. 3 in. apart from center to center and rigidly connected to one another by cross-stays and trusses, making main structure stable in thwartship direction.

"Toplis" Horizontal Luffing Cranes for Shipyards. Shipbuilder, vol. 22, no. 116, April 1920, pp. 248-250, 2 figs. Load, while jib is luffed from maximum to minimum radius or vice versa, maintains horizontal path, hoisting rope being led over suitable arrangement of pulleys to obtain this result.

CULVERTS

Wing-Wall

Unique Design of Reinforced Concrete Wing Walls. Ry Age, vol. 68, no. 16, Apr. 16, 1920, pp. 1207-1209. Application of cantilever principle is said to effect appreciable economy in L. & N. structures. Skew undercrossing, highway underpass, skew railway and wings for 9-ft. by 8-ft. culvert, are described.

CUPOLAS

British Practice

British Cupola Practice Outlined, R. R. McGowan. Foundry, vol. 48, no. 9, May 1, 1920, pp. 360-361. Among differences from American practice pointed out are stationary bottom and use of limestone and fluorspar.

CUTTING METALS

Barth Slide Rules

Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—VIII, Carl G. Barth. Indus. Management, vol. 59, no. 5, May 1920, pp. 395-399, 5 figs. Development and production of planer slide rule in its final form as arranged to solve problems dealing with feeds and speeds.

CYANIDING

Sensitiveness of Reactions

Sensitiveness of Cyanide Reactions, J. B. Ekeley and Icie C. Macy. Salt Lake Min. Rev., vol. 22, no. 2, Apr. 30, 1920, pp. 31-31. Experiments made to determine delicacy of certain tests for presence of cyanides, notably Prussian Blue test and Shonbein test.

D

DAMS

Arched

Arched Dams, B. A. Smith. Proc. Am. Soc. Civil Engrs., vol. 46, no. 3, Mar. 1920, pp. 375-425, 12 figs. Solution of arch-dam analysis is offered with a view to avoiding defect of ordinary cylinder theory. Defects claimed for latter are that, by it, arch thrust is maximum at base of dam, and that it vanishes at crest. Two cases are dealt with: (1) Complete cylindrical dam or tank of uniform thickness throughout, and (2) complete cylindrical dam or tank of uniformly varying thickness from crest to base.

Concrete

Big Eddy Storage Dam. Public Works, vol. 48, no. 14, Apr. 17, 1920, pp. 319-322, 6 figs. Concrete structure 1100 ft. long and 159 ft. high built in sections in rocky bed of Spanish River, Canada, to serve hydroelectric plants.

Hydraulic Fill

Hydraulic Fill Dams for Miami Conservancy District. Public Works, vol. 48, no. 17, May 8, 1920, pp. 301-394, 2 figs. Method of constructing earth dams with core embankments built up between side slopes enclosed by parallel levees, all made of materials excavated by dragline machines, hauled in dump cars, pumped to site and deposited by hydraulic operations.

Movable-Crest

Design and Operation of Movable Crest Dams, Wm. G. Fargo. Mun. & County Eng., vol. 58, no. 4, April 1920, pp. 157-159, 8 figs. Gates and movable weirs are classified and various means for operating gates are illustrated.

Wanaque, New Jersey

The Wanaque Dam. Public Works, vol. 48, no. 14, Apr. 17, 1920, pp. 324-330, 4 figs. North New Jersey water supply is to be provided by impounding run-off from a 94-sq.mi. water shed in a reservoir of eleven billion gallons capacity, to be built in 3½ years. Details of special construction features involved by the requirements of the rigid specifications for imperviousness of embankment and concrete; extreme depth of core-wall trench, and maintenance during first year of construction operations of continuous flow in this river and water supply to large paper mill that will remain located and operating near center of dam site for months while construction is in progress around it.

DIESEL ENGINES

Skandia Marine

First Large Marine Diesel Engines Complete on Pacific Coast, Frederik Van Rossen Hoogendyk. Pacific Marine Rev., vol. 17, no. 4, Apr., 1920, pp. 107-111, 5 figs. Description of 1100-i. hp. Diesel engines building at Skandia Pacific Oil Engine Co. under license of Dutch Werkspoor Co. for U. S. Shipping Board Emergency Fleet Corporation. Engines are 4-cycle, single-acting marine crosshead type, 20½-in. bore, 35½-in. stroke and 135 r.p.m.; built-up crankshaft is 12½ in. in diameter.

White

Two-Stroke Cycle White Diesel Engines. Shipbuilding and Shipping Rec., vol. 15, no. 16, April 15, 1920, pp. 512-514, 6 figs. Six-cylinder, 250-h.hp. engine running at 375 r.p.m., built by J. Samuel White & Co., Ltd., Isle of Wight.

DIRECTION FINDERS

Scheller

The Action of Scheller's Wireless Direction Finder from an Aeroplane (Ueber die Wirkung von Schellers drahtlosem Kursweiser auf das Flugzeug), Eberhard Buchwald. Jahrbuch Zeitschrift für drahtlose Telegraphie u. Telephonie, vol. 15, no. 2, Feb., 1920, pp. 114-122, 7 figs. Results of experiments with Scheller's wireless direction finder and telegraph patented in 1907.

DITCHES

See DRAINAGE.

DRAINAGE

Ditches, Maintenance of

Studies of Maintenance Work on Drainage Ditches, H. M. Lynde. Eng. News-Rec., vol. 84, no. 15, April 8, 1920, pp. 713-715, 2 figs. It is concluded from experiments conducted by Bur. Public Roads that channels of drainage ditches need to be cleaned annually to insure proper flow capacity and sanitary conditions, but that banks need to be cleared only at intervals of from 3 to 5 years.

Underground Systems

The Spacing and Depth of Laterals in Iowa Underdrainage Systems and the Rate of Runoff from Them with Data from Investigations, W. J. Schlick. Official Publication Iowa State College of Agriculture & Mechanic Arts, vol. 17, no. 20, Oct. 16, 1918, 119 pp. 70 figs. Investigation undertaken to collect information as to operation of typical and special underdrainage systems with a view to suggesting improvements in underdrainage systems in use.

DRAWING

Pneumatic Die Cushions

Pneumatic Cushions in Metal-Drawing Operations, John Nelson. Machy. (N. Y.), vol. 26, no. 8, Apr., 1920, pp. 726-729, 5 figs. Description of various types of pneumatic die cushions used in connection with punch presses, and methods of installing.

DRILLING

Cradle Forgings

Unusual Methods of Securing Extreme Accuracy—II, A. L. DeLeeuw. Am. Mach., vol. 52, no. 18, April 29, 1920, pp. 937-941, 16 figs. Operations of drilling and boring two main holes in cradle forging are taken up in detail. Methods used, types of tools and working limits are discussed.

DROP FORGING

Minnesota Plant

New Drop Forge Shop Built in Northwest. Am. Drop Forger, vol. 6, no. 4, April 1920, pp. 170-174, 7 figs. Attention is called to arrangement which permits of production to travel one way by electric motors, trucks and cranes.

DRYDOCKS

Floating

Floating Docks and Similar Steel Structures (Schwimmdocks und ähnliche Eisenwasserbauten), L. Karner. Eisenbau, vol. 10, no. 12, Dec., 1919, pp. 247-262, 19 figs. Notes on transverse stability of floating docks; constructive development of cross and longitudinal sections; the pontoon dock and the three-part sectional floating dock; principles of the static calculation of floating docks; etc. (Concluded.)

Philadelphia Navy Yard

Soft Ground Complicates Dry-Dock Construction, Charles A. Lee. Eng. News-Rec., vol. 84, no. 16, April 15, 1920, pp. 748-752, 7 figs. Account of changes made necessary in construction of graving dock being built at Philadelphia Navy Yard by appearances of water-bearing strata which were not indicated in preliminary borings.

DYESTUFFS

Properties of

Chemical and Physical Properties of Dye-Stuffs, J. Traube and F. Koehler. Sci. Am. Monthly, vol. 1, no. 5, May 1920, pp. 408-411. Experimental study of diffusion of acid and basic dyes in gelatin substances. Translated from Internationale Zeitschrift fuer Physikalish-Chemische Biologie.

E

EARTH

Internal Conditions

Researches at High Temperatures and Pressures, Charles A. Parsons. Sci. Am. Monthly, vol. 1, no. 5, May 1920, pp. 432-438, 8 figs. Possibility of sinking shaft twelve miles deep in earth is discussed. It is proposed to sink such shaft for exploration purposes.

ELECTRIC CIRCUITS

Protection of

Switching and Protection of Transmission Circuits, S. Q. Hayes. Elec. Jl., vol. 17, no. 5, May 1920, pp. 178-188, 29 figs. Deals principally with oil circuit breakers, relay equipment, lightning arresters, station layouts and system arrangement. A few high-voltage transformers used on some of larger systems are described. (To be continued.)

ELECTRIC CONDUCTORS

Stranded vs. Solid

Stranded vs. Solid Conductors (Litze oder masiver Draht), W. Rogowski. Archiv für Elektrotechnik, vol. 8, no. 8, Nov. 10, 1919, pp. 269-275. 4 figs. Writer refers to Lindemann's discovery that beyond a certain frequency the resistance of a stranded conductor becomes greater than that of a solid wire, and therefore advises discretion in use of strands. Calculation is made of frequency at which the solid conductor becomes preferable to the stranded one.

ELECTRIC DRIVE

See PAPER MILLS.

ELECTRIC FURNACES

Ajax-Northrup

The Ajax-Northrup Electric Furnace, Dudley Willcox. Metal Industry (N. Y.), vol. 18, no. 5, May 1920, pp. 213-216, 7 figs. It is said that there is no necessity in this type for interlinkage of magnetic circuit with electric circuit.

Carbon Electrodes, Manufacture of

Manufacture of Carbon Electrodes for Electric Furnace Purposes, Walter L. Morrison.

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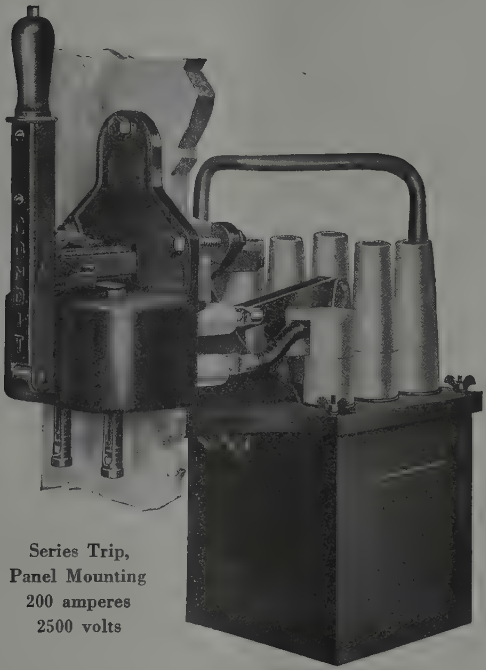

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ENGINEERING INDEX (Continued)

Chem. & Metallurgical Eng., vol. 22, no. 16, Apr. 21, 1920, pp. 741-744. Description of raw materials used and their preparation, calcining furnaces and plant operation in the "rammed process" of manufacturing electrodes for electric furnace purposes, with an outline of practical deductions obtained from experimental data.

Electrodes, X-Ray Examination of

Radiographic Examination of Carbon Electrodes, Used in Electric Steel Making Furnaces, Robert Hadfield, S. A. Main. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 76-81 and (discussion) pp. 82-88, 8 figs. on 4 supp. plates. Radiographs of electrodes obtained from different makers are presented and interpreted.

Induction

Induction Furnaces and Their Application in Iron and Steel Industries (Les fours à induction et leur application dans l'industrie du fer et de l'acier). Houille Blanche, vol. 19, no. 37-38, Jan.-Feb. 1920, pp. 12-16, 16 figs. Electrical and structural details of following types: Colby, Kjellin, Hjorth, Ferranti, Frick, Schneider, Gin, and Röchling-Rodenhauser. (To be continued.)

Metallurgical Uses

The Electric Furnace as Applied to Metallurgy, Clarence Jay West. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 35, pp. 461-552. List of magazine references on construction and operation of electric furnace as applied to metallurgy of iron and steel and non-ferrous metals.

The Position of the Electric Furnace in Iron and Steel Metallurgy, Lewis B. Lindemuth. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 39, pp. 611-627. Comparison is made betwen physical and chemical characteristics and phenomena of four steel-making processes, namely, bessemer, openhearth, crucible and electric furnace. Undue praise and claims for electric furnace method and process is deprecated, but it is claimed that when properly installed and operated it is metallurgically the best and economically the cheapest.

Operating Costs

Electric Melting in an Oil Furnace, William J. Reardon. Metal Industry (N. Y.), vol. 18, no. 5, May 1920, pp. 207-212, 4 figs. Comparative cost data of electric, Schwartz and coke pit furnaces are included.

Resistor Type

High Temperature Electric Heat-Treating Furnace, Geo. H. Holden. Sci. Am. Monthly, vol. 1, no. 5, May 1920, pp. 440-444, 11 figs. Electric furnaces of resistor type built with approval of Navy Department to fill out their contract requiring delivery of 5,000,000 of 3-in. and 4-in. gun forgings.

Transformers for

Interlacing Furnace Transformer Busbars, C. B. Gibson. Elec. World, vol. 75, no. 18, May 1, 1920, pp. 991-993, 4 figs. Scheme for interlacing bus bars for three-phase transformer.

[See also ALLOYS, Electric Production of; STEEL, HIGH-SPEED, Electric-Furnace Manufacture.]

ELECTRIC GENERATORS

See ELECTRICAL MACHINERY, Brushes; Design.

ELECTRIC LOCOMOTIVES

Brown, Boveri & Co.

The Single-Phase Locomotives of the Gothard Railway, Switzerland, Built by Brown, Boveri & Co. (Les locomotives électriques du Chemin de fer du Gothard (Suisse). Locomotives monophasées de la Société Brown, Boveri et Cie.). Génie Civil, vol. 76, no. 11, Mar. 13, 1920, pp. 265-268, 8 figs. partly on supp. plate. Locomotives operate at 15,000 volts, under frequency of 16⅔ periods, and have four motors, each of 550 hp.

Chicago, Milwaukee & St. Paul

New Electric Locomotives for the C. M. & St. P. Ry. Mech. Engr., vol. 94, no. 5, May 1920, pp. 259-264, 9 figs. Comparative study of two types recently designed for passenger service, one of 3,380 hp. built by General Electric Co., and the other of 4,200 hp. built by Westinghouse Electric & Manufacturing Co.

Critical Speed

The Critical Speed of the Lötschberg Locomotive, Type 1 E 1, Analytically and Graphically Computed (Die kritische Geschwindigkeit der Lötschberg-Lokomotive, Typ 1 E 1, analytisch und graphisch berechnet), Karl E. Müller. Schweizerische Bauzeitung, vol 75, no. 10, Mar. 6, 1920, pp. 107-110, 5 figs. Calculation said to prove that theory of the shaking vibration of driving gear is now developed to point where it can be practically applied. Reference is made to investigations and calculating methods of Couwenhoven.

ELECTRIC MEASURING INSTRUMENTS

Calibration of

New Current Balance for Calibration Work, Otto A. Knopp. Elec. World, vol. 75, no. 18, May 1, 1920, pp. 993-996, 6 figs. Testing device developed by writer and used in electrical laboratory of Pacific Gas & Electric Co. in routine calibration of ammeters and wattmeters.

ELECTRIC MOTORS

Rating

The Fifty Degree Rise Method of Motor Rating, J. M. Hipple. Elec. Jl., vol. 17, no. 5, May, 1920, pp. 203-205. Argument is presented for establishing 50 deg. rise as standard for semi-enclosed general-purpose motors and for open and semi-enclosed short-time rated motors.

Speed Regulation

Recommendations for Regulating the Speed of Electric Motors for Driving Paper Machines (Vorschläge zur Regelung der Umlaufzahl von Elektromotoren zum Antrieb von Papiermaschinen), P. Bachert. Elektrische Kraftbetriebe u. Bahnen, vol. 17, no. 36, Dec. 24, 1919, pp. 281-283, 1 fig. Writer enumerates disturbances likely to occur when transmission plant is set at lower speed, and describes an apparatus which renders it difficult or impossible to exceed a certain connection speed.

[See also ELECTRICAL MACHINERY, Brushes; Design.]

ELECTRIC PLANTS

Frequency and Voltage Standards

The Standardization of Frequency and Voltage for Electric Light and Power Plants (Vereinheitlichung der Periodenzahl und Spannungen für elektrische Beleuchtungs- und Kraftübertragungs-Anlagen). Elektrotechnik u. Maschinenbau, vol. 38, no. 9, Feb 29, 1920, pp. 93-94. Presents standards proposed by the Committee on standardization of frequency and voltage of the Electrotechnical Soc. of Vienna.

ELECTRIC POWER

Direct Generation From Fuel

Direct Generation of Electric Power from Fuels (Die unmittelbare Erzeugung elektrischer Kraft aus Brennstoffen), H. Pradel. Elektrotechnischer Anzeiger, vol. 36, nos. 151, 152-153, 154-155 and 156-157, Dec. 20, 23, 25 and 31, 1919, pp. 721-724, 727-728, 732-734 and 740-742, 17 figs. Details and illustrations of various types of apparatus patented in Germany and other countries.

ELECTRIC RAILWAYS

Braking, Regenerative

The Alternating-Current Shunt Machine as Motor and Regenerative Brake (Die Wechselstrom-Nebenschlussmaschine als Motor und Nutzbremse), Gustav Benischke. Elektrotechnik u. Maschinenbau, vol. 38, no. 7, Feb. 15, 1920, pp. 69-72, 3 figs. Writer calls attention to impracticability of series motor for regenerative braking and recommends use of shunt motor in spite of its disadvantages, because of great importance under present-day conditions of the recovery of electric motive power in the brake operation of electric railways. Reference is made to the Behn-Eschenburg article on shunt motors, published in this journal (1918, p. 553), with special regulation of stator voltage and rotor voltage.

Effect of Transportation Act of 1920 on

The Transportation Act of 1920, Charles L. Henry. Aera, vol. 8, no. 9, Apr. 1920, pp. 993-998. How provisions of section 422 of new railroad law affect interurban electric railways.

Freight Service of

The Electric Railway vs. Freight Congestion, T. H. Stoffel. Elec. Traction, vol. 16, no. 4, Apr. 15, 1920, pp. 253-256, 3 figs. Writer claims the most urgent needs at this time of electric lines engaged in freight handling, are increased terminal facilities and freight equipment, especially trailer cars.

Logging Industry, Use in

Electric Railways and Electricity For Logging Roads, John B. Woods. Elec. Traction, vol. 16, no. 5, May, 1920, pp. 311-316, 6 figs. Possibilities of electric railways as logging roads and use of electric power thus made available in woods.

Maintenance of Motors

Maintaining Electric Railway Motors—II, John S. Dean. Elec. Ry. Jl., vol. 55, no. 20, May 15, 1920, pp. 990-992, 5 figs. Practices for babbitting bearings and dipping and baking armatures are discussed, with suggestions for proper equipment necessary in this work.

Peak-Load Transportation

Handling Shipyard Traffic at Sparrows Point, L. H. Palmer. Elec. Ry. Jl., vol. 55, no. 19, May 8, 1920, pp. 930-935, 11 figs. Construction and operation of double track spur in order to solve difficulties of peak-load transportation.

ELECTRIC RAILWAYS, TRACK

Bonding Rails

Return-Conductor in the Single-Phase Alternating-Current System of the French Southern Railway (Le conducteur de retour, du courant de traction sur le réseau à courant alternatif monophasé de la compagnie des chemins de fer du midi), M. J. Lhériaud. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, vol. 70, no. 4, Oct.-Dec., 1917, pp. 831-896, 28 figs. As result of investigations it was decided not to use electric bonds, but to ground rails to moist strata at regular intervals and to install a system of transformers for maintaining current in rails. Electric bonding, it was determined, is advantageous only when trains in line are at no time farther than about 2½ miles from a substation.

[See also STREET RAILWAYS, Track Construction.]

ELECTRIC TRANSMISSION LINES

Quarter-Wave Transmission

Long Electric Transmission Lines (Sur los longues lignes de transmission d'énergie électrique), P. Brunet. Revue générale de l'Électricité, vol. 7, no. 12, March 20, 1920, pp. 395-403, 2 figs. Quarter-wave transmission for distance exceeding 600 miles in case of 50 periods per second. Quarter-wave transmission, it is noted, can be economically used for direct transmission between two points when no energy is utilized at intermediary points.

Reactance Calculation

Chart for Calculating the Reactance of a Conductor in an Electric Transmission Line (Abaque pour le calcul de la réactance d'un fil de ligne), Pantoja Leite. Revue générale de l'Électricité, vol. 7, no. 13, March 27, 1920, pp. 419-421, 2 figs. Chart permits calculation of any one of four quantities—reactance, frequency, distance between wires and diameter—in terms of the other three. It was constructed by means of a trigonometric transformation of formula giving reactance of single-phase or three-phase symmetric line.

Steel Towers

Steel Transmission Line Towers—III and IV, E. L. Gemmill. Elec. Rev. (Chicago), vol. 76, nos. 16 and 18, April 17 and May 1, 1920, pp. 645-651, 2 figs. and pp. 719-723, 4 figs. Notes on reactions for towers located on steep grades, and stringing wires on grades. Discussion of relations existing between stress, temperature and sag in transmission lines. Thomas' sag calculations are presented. Curves showing stresses of angle towers are given and relations existing between stress, temperature and sag are discussed.

Steel Wire for

Economic Use of Galvanized Steel Wire, J. P. Jollyman and J. F. Strachan. Jl. Electricity, vol. 44, no. 8, Apr. 15, 1920, pp. 356-358, 6 figs. Curves showing comparative values of steel and copper wire for electric transmission lines. It is stated that galvanized steel is more useful for carrying light loads in high voltage distribution system. Paper read before Nat. Elec. Light Assn. Convention.

ELECTRIC WELDING, ARC

Applications

Applications of Electric Arc Welding, Charles T. Perry. Textile World Jl., vol. 57, no. 19, May 8, 1920, pp. 107-109, 5 figs. Adaptability to textile-mill repair work is pointed out.

Steel Construction Work

Erects Electrically Welded Steel Structure in New York, Robert V. Ficker. Iron Trade Rev., vol. 66, no. 18, Apr. 29, 1920, pp. 1270-1272, 8 figs. Tests made by city building departments before permission to build structure by electric arc welding was given to Electric Welding Co. of America.

ELECTRIC WELDING, RESISTANCE

Boiler Tubes

Welding Boiler Tubes by the Electric Resistance Process, P. T. Van Bibber. Am. Mach., vol. 52, no. 13, Mar. 25, 1920, pp. 653-657, 8 figs. Details of process are explained and its application at various shops is illustrated.

ELECTRICAL MACHINERY

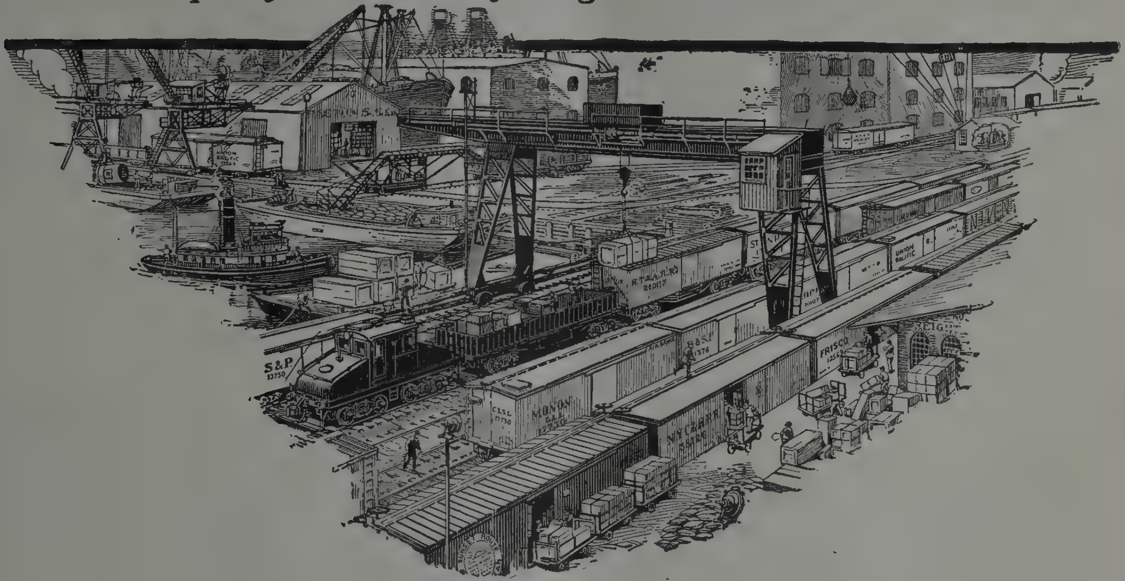
Brushes, Carbon

Standardization of Pure and Metallized Carbon Brushes (Unification des balais en charbon ou graphite pur ou métallisé). Revue générale de l'Électricité, vol. 7, no. 12, March 20, 1920, pp. 391-394, 6 figs. Specifications adopted on Jan. 7, 1920, by Committee of Union of Electrical Syndicates. Brushes for traction motors are not included.

Design of

General Theory of Vectorial Diagrams in

Intensive application of electric machinery in and about terminal warehouses is the principal factor contributing to the speedy reduction of congested conditions



Electric Power Wiping Out the High Spots in Transportation Costs

IT IS of vital importance that freight handling costs and congestions at terminals be reduced. The only way this can be efficiently accomplished is through the increased use of mechanical methods and quicker means of transportation around terminals.

Electricity as applied to these handling and transporting devices has thoroughly proved its superior worth in operating cranes, winches, stacking machines and storage battery tractors.

Tractors in one terminal enabled 100 men to load 40 cars per day, where formerly 16 cars were loaded. An electrically operated stacker can handle 50 tons of bags per hour, and raises the height of the pile from about one, or two tiers, to 15 feet from the floor.

Other electrically driven mechanical devices are operating with the same efficiency. Portable conveyors, in one case, not only released 15 men for other work, but accomplished the same unloading in one-third the time required formerly.

The numerous applications of electricity to operating locomotives, cranes, winches and stacking machines all have the same quick clearance effect on congested conditions in ports, freight depots and industrial plants.

When you submit your material handling problems to a manufacturer of this equipment, *specify G-E Motors and Electric Control.* This insures you specialized service of General Electric Company engineers co-operating with the manufacturer in the satisfactory achievement of your individual requirements.

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43-508

ENGINEERING INDEX (Continued)

Electricity (Essai d'une théorie générale des diagrammes vectoriels en électricité), Leon Otis-Chevalier. Revue générale de l'Électricité, vol. 7, nos. 10 and 11, March 7, and March 13, 1920, pp. 315-324, 2 figs. and pp 347-357, 9 figs. Theory of imaginary quantities is applied to vectorial representation of variations of principal elements in electrical generators and motors. It is assumed that currents are perfectly sinusoidal and that magnetic circuits are unsaturated, and hysteresis and Foucault losses are disregarded. Application of equations to design of various types of generators and motors is exemplified.

Symbols for

Schematic Representation of Electrical Machines, Transformers, Apparatus, Networks and Heavy-Current Installations (La représentation schématique électrique des machines, transformateurs, appareils, canalisations et installations de la catégorie dite à courant fort), A. Hayet. Revue générale de l'Électricité, vol. 7, no. 14, April 3, 1920, pp. 455-469, 24 figs. Symbols are suggested and rules are formulated for drawing out schemes of electrical installations.

ELECTRICITY

Uses in Metallurgy

Use of Electricity in Metallurgical Processes, Robert M. Keeney. Elec. Jl., vol. 17, no. 5, May, 1920, pp. 206-212. Recent applications of electricity in metallurgy are reviewed and opinion is expressed that further uses are to be expected in duplex process of cupola melting with electric-furnace refining, in process of manufacturing alloy steels, ferroalloys, aluminum, brass and electrolytic zinc, and in electric smelting of non-ferrous ores.

ELECTROLYSIS

Alternating-Current

On Alternating Current Electrolysis, S. March. Proc. Roy. Soc., vol. 97, no. A682, Apr. 1, 1920, pp. 124-144, 10 figs. Behavior of platinum, gold and nickel electrodes during passage of alternating current through different electrolytes was examined. Small bubbles of gas were formed at electrodes. Their formation is attributed to oxidation of electrode, coupled with subsequent reduction by hydrogen at next half-period, and absorption and adsorption of hydrogen by electrode coupled with recombination with oxygen at next half period.

Hydrogen Overvoltage

The Effect of an Alternating Current on Hydrogen Overvoltage. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 36, pp. 453-475, 12 figs. Lowering cathodic polarization of hydrogen by superposing alternating current on direct current was studied experimentally with platinum, lead, and copper cathodes. It was found that magnitude of depolarization is function primarily of ratio of alternating to direct current and is independent of electrodes and of current density, also that effect varies slightly with frequency, tendency being to increase as frequency is diminished.

ELECTROMAGNETS

Heating of Coils

Maximum Temperature of Coils Traversed by Current (Die Höchsttemperatur stromdurchflossener Spulen), W. Rogowski and V. Vieweg. Archiv für Elektrotechnik, vol. 8, no. 9, Dec. 8, 1919, pp. 329-332, 3 figs. Reference is made to Vidmar's article in Elektrotechnik u. Maschinenbau (vol. 36, 1918, p. 65), in which he recommends that maximum temperature of coils carrying current be determined indirectly by measurement of mean and surface temperatures. Writer presents certain measurements carried out on one coil which he claims clearly demonstrate advantages and disadvantages of Vidmar's recommendations.

Self-Induction Coefficient

The Self-Induction Coefficients of Multi-Layer Coils (Ueber den Selbstinduktionskoeffizienten mehrlagiger Spulen), A. Esau. Jahrbuch Zeitschrift fur drahtlose Telegraphie u. Telephonie, vol. 15, no. 1, Jan. 1920, pp. 2-26, 5 figs. A formula is derived for a multi-layer coil in which distances betwen layers are different from winding spaces in each layer. Tables are given for simplifying calculation of self-induction coefficients of coils. Report from laboratory of the Wireless Telegraphy Co., Berlin.

ELEVATORS

Passenger, Design of

Pasenger Elevator Service, Howard B. Cook. The Warner Elevator Manufacturing Co., Cincinnati, Ohio, 6 pp. 7 figs. Technical study of number and size of elevators required in a building. Calculations are based on rule that average elevator traffic for ten hours in an office building is equal to one passenger per hour in each direction for each 200 sq. ft. of rentable floor area in building. Paper presented at The Elevator Manufacturers' Assn. Convention.

EMPLOYEES' REPRESENTATION

Arbitration Plan

Industrial Conference Declares for Employee Representation. Indus. Management, vol. 59, no. 5, May 1920, pp. 348-354. Final report of second industrial conference held at Washington, D. C. Plan for inquiry and arbitration is presented. Greatest stress is laid upon joint organization of management and employees to secure coöperative effort. Plan of organization of nation-wide machinery of arbitration is outlined.

Argument Against

Industrial Democracy a Sham? Robert E. Newcomb. Iron Trade Rev., vol. 66, no. 8, Feb. 19, 1920, pp. 565-567. Usual form of organization of employees' and management's representatives is called "but a compromise with the bolshevik view of industrial management, leading eventually to soviet government of an industrial establishment."

Examples of Application

Employee Representation in Standard Oil, Burton Kline. Indus. Management, vol. 59, no. 5, May 1920, pp. 355-360. Scheme worked out following labor troubles of 1915. Employees meet regularly with management upon equal terms and discuss and adjust any questions that may arise as to wages, hours, working and living conditions.

ENAMELING

Cast-Iron Wares

Materials and Methods Used in the Manufacture of Enameled Cast-Iron Wares, Homer F. Staley. Dept. Commerce, Technologic Papers of Bur. of Standards, no. 142, Dec. 20, 1919, 158 pp., 5 figs. Enameling of cast iron by dry process.

Cleaning Metals for

The Electric Cleaning of Metals for Enameling Purposes, W. C. Lindemann. Jl. Am. Ceramic Soc., vol. 3, no. 3, March 1920, pp. 252-255. Practice of A. J. Lindemann & Hoverson Co. Advantages claimed for electric process are lower cost, saving in time with corresponding greater output, elimination of oxide sludge, elimination of sponging or scrubbing of ware.

ENGINEERS

Classification of

Federal Engineers Classified as to Duties and Pay. Eng. News-Rec., vol. 84, no. 16, April 15, 1920, pp. 780-781. From report covering all government employees at Washington submitted to Congress by Keating Commission.

Compensation of

Compensation for Engineers, O. C. Merrill. Professional Engr., vol. 5, no. 5, May 1920, pp. 14-15. Remark of Prof. Irving Fisher before governors and mayors assembled at White House March 3-5, 1919, that the nation is "on a permanently higher price level," is quoted and it is urged that salary scales be revised along sound principles and "in full recognition of present-day conditions." Activities of Engineering Council in the study of situation in this respect of engineers in federal, state and municipal service, are related.

Education of

Some Forces in Engineering Education, Homer A. Watt. Eng. News-Rec., vol. 84, no. 16, April 15, 1920, pp. 771-773. It is emphasized that "engineer cannot play his part by the side of educated professional men without a broader training in history, English and the social sciences," and it is therefore stated that "the engineering college which neglects the cultural elements in its curriculum will find itself, in a few years, only an industrial school."

Industrial Relations

Industrial Relations of Engineers, H. H. Higbie. Michigan Technic, vol. 33, no. 1, March 1920, pp. 23-28. Because the engineer "is usually the connecting link between capital and labor," and because he "has the trained intelligence and innate respect for verities which are essential to correct and lasting solution of the difficult relation of capital and labor," it is concluded that it is distinctly his duty to formulate a solution of social problems "which shall conform just as closely to psychological and normal laws as his usual plans and specifications conform to physical laws."

ETHER

Equation of State of

Equation of State of Ether (L'équation d'état de l'éther), E. Aries. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 15, Apr. 12, 1920, pp. 871-875. Calculation of coefficients in formula, at various temperatures up to 193.8 deg. cent., the critical temperature of ether.

EXPLOSIVES

Liquid Oxygen

Liquid Oxygen as a Blasting Medium in Mines (Flussiger Sauerstoff als Sprengmittel im Bergbau), Carl Forch. Prometheus, vol. 31, no. 12, Dec. 20, 1919, pp. 91-92. Writer describes production by means of multistage compression of air to pressure of 200 atmos. Method said to be in use in 72 coal mines, 56 ore mines and 32 potash works, producing total of 4885 liters of liquid oxygen per hour.

EXPORT TRADE

Packing for

Packing for Domestic and Export Shipping—II, Harry N. Knowlton. Am. Mach., vol. 52, no. 16, April 15, 1920, pp. 829-832, 3 figs. Types of packages and methods of handling. Definitions and descriptions of different forms of packages used in shipping goods are given, and method of handling and possibilities of damage to improperly packed commodities are taken up.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS

See GAS WORKS, Water-Gas Plant.

FATIGUE

Prevention of

Prevention of Fatigue in Industry—V, Reynold A. Spaeth. Indus. Management, vol. 59, no. 5, May 1920, pp. 409-411, 1 fig. Limitations of methods of scientific management are discussed. Claim is made that loyalty and fairness will get results in production without knowledge or use of elementary times. It is suggested that time-study methods should be standardized by a committee of representative industrialists.

FERROCHROME

[See FERROSILICON, Electric-Furnace Manufacture.]

FERROSILICON

Electric-Furnace, Manufacture

Builds Electric Ferroalloy Plant. Iron Trade Rev., vol. 66, no. 10, Mar. 4, 1920, pp. 706-707, 4 figs. Plant of United States Ferro Alloys Corp., Niagara Falls, N. Y. Principal products are ferrosilicon and ferrochrome.

Properties of

Properties of Ferrosilicon, F. A. Raven. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 37, pp. 577-588, 7 figs. Various grades of commercial ferrosilicon are described and their metallography and physical properties discussed. Their production by reduction by carbon in blast furnace is described and also their production in electric furnace. Writer declares that furnaces with high-frequency current (60 cycles), will work just as efficiently and satisfactorily as low-frequency furnaces (25 cycles), if properly designed and operated.

FERROVANADIUM

Metallurgy of

Development of Ferro-Vanadium Metallurgy, B. D. Saklatwalla. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 42, pp. 689-700. General review is given of occurrence of vanadium in nature, its discovery and its restricted utilization as rare and expensive element. Details are included of its modern introduction into large scale metallurgical practice in armor plate and special steels, and of reduction of its compounds to metal by silicon in electric furnace. Alumino-thermic reduction as practiced on a large scale in the United States is explained.

FILES

Microscopic Structure

The Microscopic Structure of Files and Chip-Forming Tools in General (Mikroskopische Struktur der Feile und spanbildende Werkzeuge im allgemeinen), W. Scheffer. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 42, no. 51, Dec. 19, 1919, pp. 393-394, 9 figs. Photomicrographs.

FIRE HOSE

Action of Water Upon

The Action of Water Upon Hose Linings and the Acid Corrosion of Jackets and Couplings, L. B. Buchanan. Nat. Fire Protection Assn.,

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vol. 13, no. 3, Jan. 1920, pp. 263-268. Tests are said to have demonstrated that practically all hose is liable to generate sulphuric acid if left wet inside for any considerable length of time in a warm room, weak acid so generated being capable of concentration to a strength sufficient to destroy fabric and corrode couplings.

FIRE PROTECTION

Sprinklers

Unsatisfactory or Serious Fires in Buildings Equipped with Sprinklers. Nat. Fire Protection Assn., vol. 13, no. 3, Jan. 1920, pp. 293-299. Examples are quoted of fires in buildings equipped with sprinklers and reasons are indicated why sprinklers failed to operate satisfactorily.

FLIGHT

High-Altitude

Flying at Very High Altitudes (La vie et les voyages aux trés hautes altitudes), Docteur Guglielmineti. Génie Civil, vol. 76. no. 12, Mar. 20, 1920, pp. 288-292, 7 figs. Physiological effects of altitudes greater than 12,000 meters (39,360 ft.). It is at such altitudes, it is said, that aerial routes for transoceanic service will have to be established in order to attain maximum practicable speed. Structural details of enclosed cabin for maintaining constant air pressure are given.

Rectilinear

The Rectilinear Flight of Aeroplanes, A. Rateau. Mech. Eng., vol. 42, no. 5, May 1920, pp. 268-269 and 316, 1 fig. Principles of analytical theory of rectilinear flight of aeroplanes are formulated. Graph is constructed indicating variation of fuel and oil consumption per distance of flight with variation in distance of plane from its ceiling during flight.

Soaring

Soaring in Horizontal Wind of Invariable Speed and Direction (Le vol à voile par vent horizontal de vitesse et de direction invariables), Jean Viley et A. Volmerange. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 14, Apr. 6, 1920, pp. 838-841, 1 fig. Study of forces acting on bird.

Trans-Pacific

Possibilities of a Trans-Pacific Flight, G. C. Westervelt and H. B. Sanford. U. S. Naval Inst. Proc., vol. 46, no. 5, May 1920, pp. 675-712, 6 figs. Discusses types of machines available, distribution and physical conditions of possible landing places, and meteorological conditions of various routes.

FLOOD PREVENTION

Water Flow Through Contracted Channel

Experiments on the Flow of Water Through Contractions in an Open Channel, E. W. Lane. Proc. Am. Soc. Civil Engrs., vol. 45, nos. 8-9-10, Oct.-Nov.-Dec., 1919, pp. 717-774, 20 figs. Studies for design of flood prevention works of Miami Conservancy District. Measurements were made of flow through (1) contraction with rounded edges, (2) sharp-edged contraction, (3) short flume with rounded entrance, (4) short flume with sharp corner entrance, and (5) expanding or venturi flume.

FLUE GASES

Water Vapor in

The Specific Heat of the Water Vapor in Flue Gases (Die spezifische Wärme des Wasserdampfes in Feuergasen), H. Hilliger. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 10, Mar. 6, 1920, pp. 234-236, 3 figs. It is pointed out that the pressure of the water vapor in flue gases is considerably less than 1 atmos., so that as result of dependence of specific heat on pressure, the values in general use are no longer applicable. Values for low pressure are derived from results of tests carried out at Münich and the mean specific heat is determined from saturation temperature. Calculations of mean specific heat for other temperature limits are also given.

FLYWHEELS

Equalizers

Recent Improvements in Flywheel Equalizers for Electric Conveying Plants (Neuere Schwungradpufferungen in elektrischen Förderanlagen), W. Wolf. Kali, vol. 13, no. 23, Dec. 1, 1919, pp. 388-394, 8 figs. Details and illustrations of various devices recently patented.

FOREMAN

Place in Industrial Management

The Foreman, Sanford E. Thompson. Bul. Taylor Soc., vol. 5, no. 1, Feb. 1920, pp. 43-46 and (discussion) pp. 46-48. Scientific management, it is observed, has given a definite place to foreman in industry and has clearly outlined his position with reference to the workman.

FOUNDATIONS

Testing Subsoil

Foundations, Their Selection, Design and Construction. Am. Architect, vol. 117, no. 2314, April 28, 1920, pp. 533-536, 4 figs. Design of platform is suggested for testing soil bearing.

Unstable Sands

The World's Most Modern Pipe Plant, Francis Judson Tietsort. Compressed Air Mfg., vol. 25, no. 4, April 1920, pp. 9599-9602, 9 figs. Structures were built upon unstable water bearing ground situated under water and exposed to action of wind and tide. Sandy bottom under from 14 to 25 ft. of water of Lake Michigan was reclaimed. Steel encased concrete pillars were used.

FOUNDRIES

Electricity in

Foundry Applies Electricity to Many Operations, H. R. Simonds. Foundry, vol. 48, no. 345, April 15, 1920, pp. 301-303, 5 figs. Steel foundry of Connecticut Electric Steel Co., Hartford, Conn., in which electricity is used for making steel, baking cores, annealing and heat-treating castings, and in cleaning room, as well as in melting and refining steel.

Organization of

New Foundry is Model of Efficiency. Foundry, vol. 48, no. 9, May 1, 1920, pp. 345-349, 7 figs. Organization of foundry at Cincinnati is said to permit maximum production with unskilled labor.

[See also AEROPLANE ENGINES, Piston Rings.]

FREIGHT HANDLING

England

Freight Handling in England as Applied to Our Home Problem, F. T. Chambers. Pacific Marine Rev., vol. 17, no. 4, Apr. 1920, pp. 53-56 and 104-106, 7 figs. Address delivered before Material Handling Mach. Manufacturers' Assn., with illustrations from author's report published by U. S. Shipping Board.

FUELS

Carbozite (Lignite Product)

The Chemical Utilization of Coal and the Improvement of Low-Grade Fuels (Die chemische Auswertung der Kohle und die Veredlung geringwertiger Brennstoffe), K. Theiler. Braunkohle, vol. 18, no. 32, Nov. 8, 1919, pp. 419-420. It is claimed that in low-temperature carbonization a method has been found for improving inferior fuels by chemical preparation, and that this points to the possibility of producing flaming coal (called carbozite) from lignites not adapted to production of briquets, and from peat.

The Low Temperature Carbonization of Low-Grade Fuels, Especially of Lignites (Die Tieftemperaturverkohlung geringwertiger Brennstoffe, insbesondere der Braunkohle), H. Theiler. Braunkohle, vol. 18, no. 33, Nov. 15, 1919, pp. 431-434, 2 figs. Notes on manufacture of carbozite, a lignite product whose heating value is three times that of lignite and which burns with a long clear flame and is practically smokeless.

Colloidal

Colloidal Fuel and Its Use—II, Lindon W. Bates. Chem. Engr., vol. 28, no. 4, April 1920, pp. 125-127. Nature of colloidal fuel, its development during war, results by tests, with review of present and future general industrial possibilities.

Research, British

Report of the Fuel Research Board for the Years 1918, 1919. Dept. Sci. Indus. Research, Lond., 1920, 57 pp., 5 figs. Account of survey of coals of Great Britain in particular as to suitability of different types of known origin for conversion into gases, fuel oils and coke, and also account of work undertaken with a view to obtaining thermal and economic data in connection with use of peat as fuel. Use of pulverized fuel in operations of various kinds is taken up and records are given of effects of purely meteorological conditions on natural draft of a chimney.

[See also PEAT; PULVERIZED COAL.]

FURNACES, BOILER

Bagasse

Bagasse Furnaces, A. G. Budge. Int. Sugar Jl., vol. 22, no. 256, Apr. 1920, pp. 211-214, 4 figs. Types used in factories in Hawaii.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEAT-TREATING

See ELECTRIC FURNACES, Resistor Type.

FURNACES, INDUSTRIAL

See HEATING, ELECTRIC, Industrial; STEEL, HEAT TREATMENT OF, Furnaces.

G

GAGES

Gage Blocks, Manufacture of

How Precision Gage Blocks are Made, Franklin D. Jones. Machy. (N. Y.), vol. 26, no. 8, Apr., 1920, pp. 697-708, 27 figs. Practice of Pratt & Whitney Co., Hartford, Conn.

Indicating and Contour

Indicating and Contour Gages, John E. Collins. Machy. (N. Y.), vol. 26, no. 8, Apr., 1920, pp. 732-736, 11, figs. Gages in which indications are read off by sight are divided into five classes, which with other unclassified gages are described.

GAS ENGINES

Farm-Pump

Manufacturing a Farm Pump Engine, J. V. Hunter. Am. Mach., vol. 52, no. 18, April 29, 1920, pp. 943-946, 11 figs. Small pump operated by gas engine, manufactured by Fuller & Johnson Co., Madison, Wis.

German Mine Plant

The Gas Power Station of the Bergmannsglück Mine in Westphalia (Die Gaskraftwerk auf der Schachtanlage Bergmannsglück, Buer i. Westf.), Oel- u. Gasmaschine, vol. 17, no. 2, Feb. 1920, pp. 17-20, 6 figs. It is claimed that by the use of gas engines 1 kg. of fuel is saved for every kw-hr. Description and illustrations of engine plant, which is equipped with 2350-hp. double-acting 4-stroke engines in tandem arrangement, with cylinders of 1250 mm. diameter and 1300 mm. stroke.

Lighting-Unit, Machining

Machining the Gas Engine for a Lighting Unit, J. V. Hunter. Am. Mach., vol. 52, no. 15, April 8, 1920, pp. 765-767, 7 figs. Unit combining single-cylinder kerosene engine direct-connected to 1½-kw. generator, and operating in connection with storage battery.

GAS WORKS

Light-Oil Recovery Plant

Plant for Recovery of Light Oils at the Vienna-Simmering Gas Works (Die Leichtölanlage des Gaswerkes Wien-Simmering). Zeitschrift für komprimierte u. flüssige Gase, vol. 20, no. 6, 1919, pp. 62-63, 1 fig. Description and schematic diagram of Still system plant in a gas works having a daily output of 18,000,000 cu. ft.

Water-Gas Plant

Electrically-Driven Blast-Fans, H. C. Widlake. Gas Jl., vol. 150, no. 2971, Apr. 20, 1920, pp. 131-133, 2 figs. Description of water-gas plant which comprises four gas-making sets served by three no. 8 Sturtevant blast-fans.

GASOLINE

Alcogas vs. Aviation Gasoline

Comparative Power Properties of Alcogas and Aviation Gasoline, V. R. Gage, S. W. Sparrow and D. R. Harper. Automotive Industries, vol. 42, no. 18, April 29, 1920, pp. 1018-1020, 9 figs. Results of tests using 12-cylinder Liberty engine under varying conditions. Alcogas (mixture of 40 per cent alcohol, 35 per cent gasoline, 17 per cent benzol, and 8 per cent other ingredients) showed about 15 per cent higher thermal efficiency than standard "X" gasoline. From report no. 89 of Nat. Advisory Committee for Aeronautics.

Cherry Production Process

A New Method of Motor Spirit Production, Louis Bond Cherry. Petroleum Times, vol. 3, no. 66, April 10, 1920, pp. 383-384. Cherry process for producing gasoline and other hydrocarbons by electrochemical means.

GASOLINE ENGINES

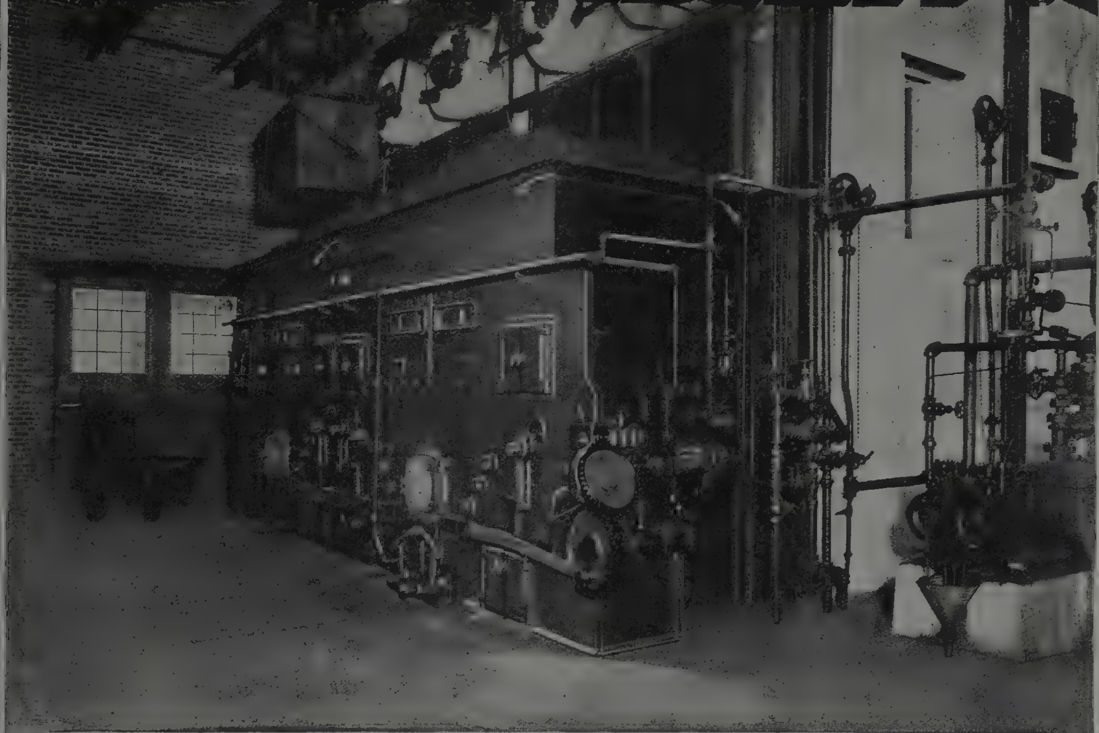
British Marine, Specifications

Individual Models of the British Marine Engine Builders, M. W. Bourdon. Automotive Industries, vol. 42, no. 20, May 13, 1920, pp. 1098-1105, 18 figs. Abbreviated specifications of British marine engines of gasoline and kerosene types, together with range of standard sizes, prices and weights.

Turner-Moore

New Engine Has Unusual Oil System and Valve Setting. Automotive Industries, vol. 42, no. 17, April 22, 1920, pp. 946-947, 5 figs. Turner-Moore 3⅛ x 5 in., four-cylinder general purpose engine. It develops 37 b.h.p. at 2200 r.p.m. Distinguishing features are hollow crankshaft and accentuated inclination of valves.

DEPENDABILITY



Recently the hand fired boiler units of the Sterling Tire Corporation of Rutherford, N. J. were replaced by Murphy Furnaces firing 300 HP. boilers. Steam from these boilers is used wholly in the process of tire making. In order that no damage may be done to the tires in going through the vulcanizing process it is of the utmost importance that there should be no interruption in the supply of steam.

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qualify for this exacting service requiring absolute dependability, because they are designed right and built right. All parts are massive and well protected. The magazines and fronts are protected by fire brick; the coking plates, by air passing under them; the arch, by the circulation of air about it; the clinker grinder, grate bearer and grates, by exhaust steam and air underneath.

To learn more of the dependable service furnished by Murphy Furnaces in firing over 6000 boilers, write for catalog A-7

MURPHY IRON WORKS, Detroit, Michigan

BURNS ANY FUEL THAT HAS HEAT IN IT

ENGINEERING INDEX (Continued)

GEAR CUTTING

Automobile Gears

Gear Cutting for Motor Cars, P. J. Worsley. Automobile Engr., vol. 10, no. 137, April 1920, pp. 162-169, 24 figs. Description of Fellows gear cutter, Sunderland bevel gear planer, gear hobbing machines manufactured by Reinecker & Wallwork Co. and other machines.

GEARS

Bevel

Generating Bevel Gears, Francis W. Shaw. Machy. (Lond.), vol. 16, no. 394, April 15, 1920, pp. 41-45, 4 figs. Discusses question whether or not root angle must correspond to pressure angle.

GIRDERS

Reinforced-Concrete

Determination of the Most Economic Reinforcement of Double-Reinforced Slabs and Girders (Die Bestimmung der wirtschaftlich günstigsten Armierung doppelt armierter Platten und Balken), H. Lührs. Armierter Beton, vol. 12, no. 12, Dec. 1919, pp. 315-317, 1 fig. Equations and chart for computing required reinforcement.

GOLD MINING

Electrical Equipment for

Choice of Electrical Equipment for Gold and Silver Mining, B. B. Beckett. Jl. Electricity, vol. 44, no. 9, May 1, 1920, pp. 440-442. Article based on writer's experience in mines of Goldfield, Nev.

GRAPHITE

Determination in Mineral Deposits

The Problem of Determining Graphite Carbon. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 40, pp. 629-658, 3 figs. Experiments undertaken by Bureau of Mines to determine per cent of graphitic carbon in certain graphite-like mineral deposits and coke.

GRADE CROSSINGS

Construction and Maintenance

Construction and Maintenance of Grade Crossings on Pacific Electric, Clifford A. Elliott. Elec. Ry. Jl., vol. 55, no. 20, May 15, 1920, pp. 995-998, 5 figs. Where soil will not produce natural crossing on interurban lines graded and oiled and oil macadam crossings are standard. Central plant erected for heating oil and mixing macadam.

GRAVITATION

See RELATIVITY.

GRINDING MACHINES

Standard Classification

The Standardization of Grinding Machine Classification, S. M. Henry. Am. Mach., vol. 52, no. 14, April 1, 1920, pp. 736-737. Classification employed by Bureau of Construction and Repair, Navy Department.

GROUTING

Catskill Water Supply Structures

Grouting Operations, Catskill Water Supply, James F. Sanborn and M. E. Zipser. Proc. Am. Soc. Civil Engrs., vol. 46, no. 1, Jan. 1920, pp. 1-80, 12 figs. Summary of experience and results obtained in use of grout in construction of aqueduct, dams, and other structures of Catskill Works. Mixture consisting of one bag of cement, one bag of sand, and from 6 to 8 gal. of water, was found to be well adapted for backing-up and filling spaces behind tunnel linings. Air pressure used varied from 30 to 90 lb. per sq. in.

GUN MANUFACTURE

Breech Mechanism

Machining Problems Solved in Gun Making —V, J. V. Hunter. Am. Mach., vol. 52, no. 14, April 1, 1920, pp. 733-735, 13 figs. Tools and fixtures applied to finishing breech mechanism of 4.7-in. gun.

One-Piece Construction

An Experiment in One-piece Gun Construction, P. W. Bridgman. Min. & Metallurgy, no. 158, section 14, Feb. 1920, 16 pp. 10 figs. Experiment was undertaken by U. S. Navy. Procedure was to start with single forging of approximately the dimensions of the finished gun subject it to internal hydrostatic pressure of about 100,000 lb. per sq. in., and thus raise elastic limit by producing compression in inside layers of the barrel and tension in outside layers, and then to machine gun to final dimensions.

H

HANDLING MATERIALS

Gravel, Mechanical Loader for

Mechanical Loaders Handle Gravel at Low Cost, P. Philip. Contract Rec., vol. 34, no. 17, Apr. 28, 1920, pp. 385-386, 4 figs. Experience in British Columbia. Figures are given showing comparative costs of loading trucks by hand and by mechanical loader.

Machine Shops

Handling Material at the Plant of the Greenfield Tap and Die Corporation, Peter F. O'Shea. Am. Mach., vol. 52, no. 17, April 22, 1920, pp. 880-884, 5 figs. Plant turns out small gages, taps and dies. Material travels in machine shop from left to right, coming in at windows at left as raw material and falling into aisle at right in form of blanks. Blanks are separated into lots and assigned to corresponding departments.

Pneumatic System for Calcium Sulphide

Pneumatic Handling Installation for Calcium Sulphide, G. F. Zimmer. Chem. Age, vol. 2, no. 43, April 10, 1920, pp. 372-373, 4 figs. Installation at Works of Deutsche Claus-Schwefel-Gesellschaft, Bernburg, Germany.

HEAT TREATMENT

See STEEL, HEAT TREATMENT OF

HEATING, ELECTRIC

Industrial

Industrial Electric Heating, Wirt S. Scott. Elec. Jl., vol. 17, no. 5, May 1920, pp. 188-192, 13 figs. Recent applications of electric heating in various industries are pointed out and possibilities of electric heating for forging furnaces, brass-melting furnaces, hardening furnaces, tempering and annealing furnaces, sherardizing furnaces, etc., are outlined.

HEAVY-OIL ENGINES

See MARINE ENGINES, Heavy-Oil.

HELICOPTERS

See AEROPLANES, Helicopters.

HIPPODROME

Copenhagen, Reinforced-Concrete

The New Reinforced-Concrete Hippodrome in Copenhagen (Le nouveau cirque de Copenhague, en béton armé). Génie Civil, vol. 76, no. 11, Mar. 13, 1920, pp. 273-275, 5 figs. Attention is specially directed to method of setting up reinforcing members of dome, each of which was 20 m. long and weighed 20 tons.

HOISTS

Electric

Designing an Electric Hoist to Meet Needs of a Long Mine Slope, Graham Bright. Coal Age, vol. 17, no. 19, May 6, 1920, pp. 890-894, 10 figs. Hoist consists of single cylindrical drum 9 ft. in diameter, having ultimate capacity of about 13,000 ft. of 1¼-in. cable. Drum is geared to 800-hp., 2200-volt, three-phase 60-cycl, 24-pole, pedestal-type, wound-rotor, induction motor.

Electric Winding Engines and Mine Hoists, H. H. Broughton. Elecn., vol. 84, nos. 2184 and 2188, March 26 and April 23, 1920, pp. 340-343, 5 figs. and pp. 441-443, 3 figs. Rating of winder motors. Calculations involved in design of mine hoist are illustrated with 10,000-lb. rock hoist for inclined shaft of varying slope.

HOUSES, CONCRETE

England

Concrete Cottage Building Cottages at Amesbury. Concrete & Constructional Eng., vol. 15, no. 4, April 1920, pp. 234-242, 5 figs. Thickness of walls is 7½ in., and they are composed of two 2½-in. skins with a 2½-in. cavity. Two inch blocks were used which in tests showed contraction of 1/512 in. in 27 in. at 20 deg. fahr. below frezing, and expansion of 1/127 in. in 27 in. at 120 deg. fahr.

Monolithic

Field Practice on Monolithic Concrete Houses. Contract Rec., vol. 34, no. 14, April 7, 1920, pp. 329-331. Outline of practicable erection methods. Report presented at National Conference on Concrete House Construction.

HOUSING

See PAPER MILLS.

HYDRAULIC TURBINES

Tests

Results of Brake Tests of a Kaplan Turbine (Bremsergebnisse an einer Kaplanturbine), Berthold Blümel. Elektrotecnik u. Maschinenbau, vol. 38, no. 6, Feb. 8, 1920, pp. 61-63, 8 figs. Tests of high-speed, high-efficiency turbine of about 40 hp. operating under head of 8 to 10 ft.

Wear of

The Wear of Hydraulic Turbines, Its Consequences and the Method of Reducing it (L'usure des turbines hydrauliques, ses conséquences et les moyens d'y parer), Henri Dufour. Bulletin Technique de la Suisse Romande, vol. 46, no. 7, Apr. 3, 1920, pp. 75-78, 3 figs. Experiments made at Klösterli Works (Valais) in order to determine extent to which efficiency of turbine was diminished as result of wear caused by loams in water. (Continuation of serial.)

HYDROELECTRIC PLANTS

Construction Work

Duties of a Young Engineer on the Construction of a Hydro-Electric Plant, H. S. Slocum. Can. Engr., vol. 38, no. 16, April 15, 1920, pp. 375-384, 29 figs. As examples of method of organizing work for construction of hydroelectric project, operations undertaken in construction of plant of Cedar Rapids Mfg. & Power Co. and Appalachian Power Co. are outlined.

France

Navigation and Harnessing of the Rhine (Le Rhin aux points de vue de la navigation et des forces hydrauliques), B. Seitre. Vie Technique & Industrielle, vol. 1, no. 6, Mar. 1920, pp. 457-462, 4 figs. Hydroelectric installation projected near Mulhouse. (Concluded.)

I

INDUCTION COILS

Resonance

Electric Resonance in a Coil with an Iron Core (Résonance électrique dans un circuit dont la self-induction contient du fer), P. Boucherot. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 12, March 22, 1920, pp. 725-728, 2 figs. Formula for determining excess voltage resulting from grounding conductor in long cable.

Remotely Controlled

Remotely Controlled Hydroelectric Synchronous Generators, Charles H. Tallant. Jl. Electricity, vol. 44, no. 9, May 1, 1920, pp. 432-433, 3 figs. Automatic installation at Ontario, Cal., by Ontario Power Co. Equipment consists of one single Pelton impulse turbine, overhung from Westinghouse 500-kva., 50-cycle generator. Plant is controlled with double-throw switch from another plant situated three and one-half miles down canyon.

Switzerland

The Water-Power Plant "Gosgen" on the Aare River (Die Wasserkraftanlage "Gosgen" an der Aare der A.-G. Electrizitätswerk Olten-Aarburg). Schweizerische Bauzeitung, vol. 75, nos. 9 and 10, Feb. 28 and Mar. 6, 1920, pp. 93-96 and 110-113, 24 figs. Description and illustrations of the head-water canal, entire length of which is 4.80 km., construction involving approximately excavation of 1,100,000 cu. m. of earth and 250,000 cu. m. of rock. (Continuation of serial.)

INDICATORS

Steam-Engine

High-Speed Indicators, Thomas Midgley, Jr. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 254-257, 11 figs. Classification and description of various types of steam-engine indicators, particularly type developed at Bur. of Standards.

INDUSTRIAL MANAGEMENT

Analysis of Shop Methods

Improving Shop Methods by Analysis—II, L. V. Estes. Indus. Management, vol. 59, no. 5, May 1920, pp. 367-371. It is shown how analysis provides facts upon which shop man can base improvement of his methods.

Purchasing Data, Recording

Economic Value of Good Buying, Wilfred G. Astle. Elec. Traction, vol. 16, no. 5, May 1920, pp. 324-326. Emphasizes economy of introducing efficient system of keeping all buying data.

Records, Filing of

Purchasing Department Records, G. W. Greenwood. Indus. Management, vol. 59, no. 5, May 1920, pp. 383-386, 4 figs. Method is suggested for filing filled purchase orders so that any particular item can be readily located with no other information than name of part in question.

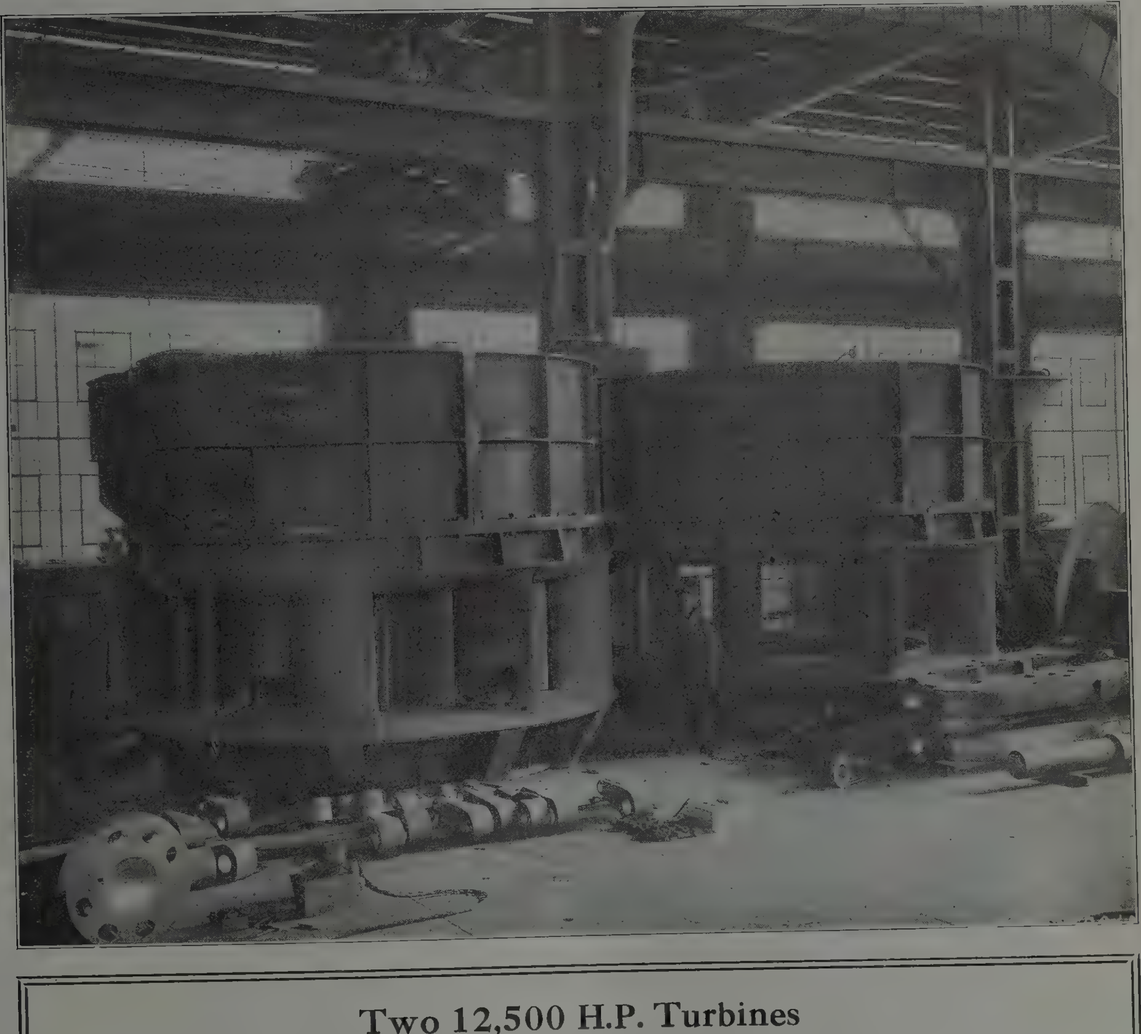
Shipyards

Industrial Engineering Applied to Shipyard Management, Norman Howard. Indus. Man-

I. P. Morris Hydraulic Turbines

The Wm. Cramp & Sons Ship & Engine Building Co.

Richmond and Norris Sts., Philadelphia



Two 12,500 H.P. Turbines

Built for the Hydro-Electric Power Commission of Ontario
Nipigon Development—Cameron Falls, Ontario

An order has recently been received for 3—55,000 H.P. TURBINES
(Most Powerful Ever Built) for the Niagara Development of the
Hydro-Electric Power Commission of Ontario

THIS COMPANY IS NOW BUILDING JOHNSON VALVES FOR THE
LARNER-JOHNSON VALVE & ENGINEERING CO.

agement, vol. 59, no. 5, May 1920, pp. 372-376, 4 figs. Work done by Industrial Management Section of Emergency Fleet Corporation. (To be continued.)

Stores System

Modern Stores System Proves Successful in Strip Mill, H. R. Simonds. Iron Trade Rev., vol. 66, no. 17, Apr. 22, 1920, pp. 1197-1202, 10 figs. Record forms used in stores system of Am. Tube & Stamping Co., Bridgeport, Conn.

[See also COAL MINES, Management Methods; FOREMEN; FOUNDRIES, Organization of; PRODUCTION; TIME STUDY.]

INDUSTRIAL RELATIONS

See ENGINEERS, Industrial Relations.

INSULATION

See WALLS, Heat Insulation of.

INSULATORS, HEAT

Thickness Required

Heat Insulation. Power Plant Eng., vol. 24, no. 10, May 15, 1920, pp. 514-516, 1 fig. Diagram for finding correct thickness of various insulating materials.

INTERCHANGEABLE MANUFACTURE

Equipment for

Equipment for Interchangeable Manufacturing, Earle Buckingham. Machy. (N. Y.), vol. 26, nos. 8 and 9, Apr. and May 1920, pp. 754-760 and 828-833, 32 figs. Discussion of principles to be considered in selection of machine tools and in designing jigs, fixtures and cutting tools for interchangeable manufacture. Description of jigs used in machining an automobile transmission case, and other examples.

INTERNAL-COMBUSTION ENGINES

Lubricants for

Tests of Lubricants for the Internal Combustion Engine, Fred C. Ziesenheim. Automotive Industries, vol. 42, no. 17, April 22, 1920, pp. 960-962, 1 fig. Outline of method of testing engine with different kinds of oil and manner of determining which is best suited for particular conditions under which engine is intended to operate.

Olympia Show

Motor Boat and Marine and Stationary Engine Exhibition. Automobile Engr., vol. 10, no. 137, April 1920, pp. 155-156, 6 figs. Also article similarly entitled in Mar. Eng. & Naval Architect, vol. 42, no. 511, April 1920, pp. 260-262, and p. 272, 6 figs. Notes on types exhibited at Olympia Show.

Testing Plant

A Modern Testing Station. Automobile Engr., vol. 10, no. 137, April 1920, pp. 134-138, 14 figs. Research works of Messrs. Ricardo & Co., Engineers, Ltd., England, for internal-combustion engine investigations.

[See also DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; KEROSENE ENGINES; MARINE ENGINS; Heavy Oil.]

IRON

Brittleness and Aging

The Brittleness at Blue Heat and the "Aging" of Iron (Uber die Blaubrüchigkeit und das Altern des eisens), H. Wetzel. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 1, Aug., 1919, pp. 43-48, 5 figs. Results of various experiments are described and are said to show that relationship exists between the brittleness at blue heat and the so-called "aging" of iron, and that both phenomena are characteristically similar peculiarities of iron.

Grading in Great Britain

Grading Iron in Great Britain, Joseph Horton. Iron Trade Rev., vol. 66, no. 12, Mar. 18, 1920, pp. 843-845. It is said that fracture test is still largely used in determining quality of material, although more consumers are insisting on analysis. Other British practices in selling iron and steel are explained and special terms used are defined.

[See also STEEL, Properties below Critical Range.]

IRRIGATION

Pacific Northwest

The Duty of Water in the Pacific Northwest, J. C. Stevens. Proc. Am. Soc. Civil Engrs., vol. 46, no. 3, Mar. 1920, pp. 461-480, 1 fig. By duty of water is meant average percentage of soil mixture that should be maintained for particular soil and crops. Quantity of irrigation water that, with precipitation and unavoidable losses, will maintain required amount of soil moisture in Pacific Northwest region of United States, is investigated.

K

KEROSENE ENGINES

Cafford

New French Kerosene Engine Has Single Sleeve Valves, W. F. Bradley. Automotive Industries, vol. 42, no. 18, April 29, 1920, p. 1009, 2 figs. Engines which secured prize given by Automobile Club of France are now being built by Cafford Company of Paris. Kerosene is used according to Bellem and Bregeras system. Engines are built with one, two or four cylinders, and have bore and stroke of 4.3 x 6.2 in. They have single sleeve driven by eccentric off a half-time shaft in base chamber. Horsepower obtained from 4-cylinder engine is 23 at 600, 25 at 700 and 30 at 800 r.p.m.

[See also GASOLINE ENGINES, British Marine.]

L

LABOR

Great Britain

The Course of Labor and the Workers' Tendency in Great Britain, Clarence H. Northcott. Automotive Industries, vol. 42, no. 17, April 22, 1920, pp. 970-973. Attitude of labor in regard to increased production. It is said that in spite of placards and notices emphasizing the necessity for increased production in country, "labor is little interested" and "they do not see either the use or necessity of continued toil."

LATHES

Double-End Center-Drive

Greenlee Double-End Center-Drive Lathe, J. V. Hunter. Am. Mach., vol. 52, no. 16, April 15, 1920, pp. 815-817, 4 figs. Lathe developed by Greenlee Bros. Co., Rockford, Ill., for turning both ends of automobile axle at the same time, and now being applied to bar and shaft work requiring turning only on ends.

Turret

Turret Lathe Practice. Machy. (Lond.), vol. 16, no. 394, April 15, 1920, pp. 29-35, 16 figs. Methods employed in machining large gas-engine pistons at works of Alfred Herbert, Ltd., England.

LEAD

Intercrystalline Brittleness

Intercrystalline Brittleness of Lead, Henry S. Rawdon. Min. & Metallurgy, No. 158, Section 7, Feb. 1920, 16 pp., 11 figs. Corrosion of lead during service, resulting from attack of metal along crystal boundaries, is characterized as cause of metal crumbling easily into grains. Research was made at Bureau of Standards.

LEAD ORE

Formation

Rapid Formation of Lead Ore, H. A. Wheeler. Min. & Metallurgy, No. 158, Section 25, Feb. 1920, 4 pp., 1 fig. Copious deposition of lead sulphide on railway spike found on mine which had been abandoned for two years, is quoted as proof that deposition can be very rapid under favorable conditions.

German Industry

The Lead and Zinc Ore Trade in Germany (Der Handel mit Blei- und Zinkerzen in Deutschland), H. Schnass. Metall u. Erz, vol. 17, nos. 2 and 3, Jan. 22 and Feb. 8, 1920, pp. 27-34 and 61-75. Notes on the German lead and zinc industry, and conditions up to outbreak of war. An appendix discusses application of price-calculating formulæ in connection with the altered war conditions.

LIGHTING

Indirect

Artistic Lighting of a Large Interior, J. R. Cravath. Elec. World, vol. 75, no. 17, April 24, 1920, pp. 939-941, 4 figs. Indirect lighting of dome, 200 ft. in diameter, in hotel. Eighteen 1000-watt lamps are used.

Industrial, Cost of

Notes on Industrial Lighting, Otis L. Johnson. Elec. Jl., vol. 17, no. 5, May 1920, pp. 198-201, 9 figs. Cost of efficient industrial lighting is investigated and it is found that good illumination can be installed and operated for less than 1 per cent of average workman's wages.

Street

Ornamental Street Lighting, L. A. S. Wood. Elec. Jl., vol. 17, no. 5, May 1920, pp. 195-197, 10 figs. Various designs of posts and lanterns are illustrated.

LOCOMOTIVES

British

British Locomotive Practice: 1914-1919, J. F. Gairns. Bul. Int. Ry. Assn., vol. 2, no. 1-2-3, Jan-Feb.-March 1920, pp. 3-16, 6 figs. In regard to cylinder arrangement, reference is made to experiments with uniflow cylinders, which were followed by construction of three-cylinder 4-4-2 express locomotive on this principle. Construction of two 4-6-0 four-cylinder locomotives is also reported.

Efficiency, Increasing

Increasing Locomotive Efficiency and Capacity, B. B. Milner. Ry. Mech. Engr., vol. 94, no. 5, May 1920, pp. 265-268, 5 figs. Improvements suggested include feedwater heating, trailer booster, lighter rods and cut-off regulation. Paper read before New York Railroad Club.

Increasing Locomotive Operating Efficiency, R. S. Mounce. Ry. Age, vol. 68, no. 16, Apr. 16, 1920, pp. 1191-1196, 5 figs. Notes on adapting design to service conditions, modernizing, reassigning and accurate train loading.

Electric

See ELECTRIC LOCOMOTIVES.

English Superheater

New Locomotives for the Great Central Railway. Ry. Gaz., vol. 32, no. 15, April 9, 1920, pp. 556-557, 3 figs. Express locomotives of 4-4-0 type. Particulars are: Cylinders, 28-in. diameter by 26-in. stroke; working pressure, 180 lb. per square inch; heating surface, total, 1752 sq. ft.; superheater, inside, 209 sq. ft.

Feedwater Heating

Locomotive Feedwater Heating, Thomas C. McBride, Mech. Eng., vol. 42, no. 5, May, 1920, pp. 283-286 and 316, 5 figs. Pump and open type heater manufactured by Worthington Pump and Machinery Corp. are described and results of tests of their operation are presented.

French

The Evolution of the High-Speed Locomotive in France, Between 1878 and 1914, and the Influence of Alsatian Practice, A. Herdner. Bul. Int. Ry. Assn., vol. 2, no. 1-2-3, Jan.-Feb.-March, 1920, pp. 17-44, 13 figs. Attention is especially directed to development of Mallet compound type, first constructed in 1878 and introduced into many other countries since that time. Comparative economies of various types of locomotives equipped with turbo heaters are discussed.

LOGGING INDUSTRY

See ELECTRIC RAILWAYS, Logging Industry, Use in.

LUBRICATING OILS

Castor Oil, Manufacture of

Operation of the Gainesville Castor Oil Plant, J. H. Shrader and A. C. Goetz. Chem. & Metallurgical Eng., vol. 22, no. 18, May 5, 1920, pp. 833-838, 5 figs. Details of installation and solvent extraction process of obtaining high recovery of oil from castor beans.

M

MAGNESITE

See REFRACTORIES, Magnesite.

MAGNESIUM ALLOYS

Dow Metal

A New Light Piston Alloy. Automotive Industries, vol. 42, no. 17, April 22, 1920, p. 967. Dow metal manufactured by Dow Chemical Co. It contains over 90 per cent of magnesium, it is said, and possesses tensile strength of from 22,000 to 25,000 lb. per sq. in., modulus of elasticity of 9,000,000 lb. per sq. in. and specific gravity of 1.79.

Electron Metal

The Casting of Electron Metal (Ueber das Vergiessen von Elektronmetall), Felix Thomas. Stahl u. Eisen, vol 40, no. 9, Feb. 26, 1920, pp. 290-297, 14 figs. Notes on molding sand used and its preparation; making and drying the molds; melting and casting of the electron metal (a magnesium alloy); strength and other physical properties of castings produced. Illustrations of typical castings are included.

MALLEABLE IRON

See PULVERIZED COAL, Melting Iron with.

MANGANESE-GOLD ALLOYS

See ALLOYS, Manganese—Gold.

MARINE ENGINES

American

Marine Motors "Built in U. S. A." Motor Boat, vol. 17, no. 8, April 25, 1920, pp. 21-31.

Number Three of a Series

Working Points

(Not Talking Points or Selling Points)

of the Hartness Flat Turret Lathe

Friction Speed Changes

Cross sliding Head is a shallow pan, all gears running in oil, all bearings splash lubricated.

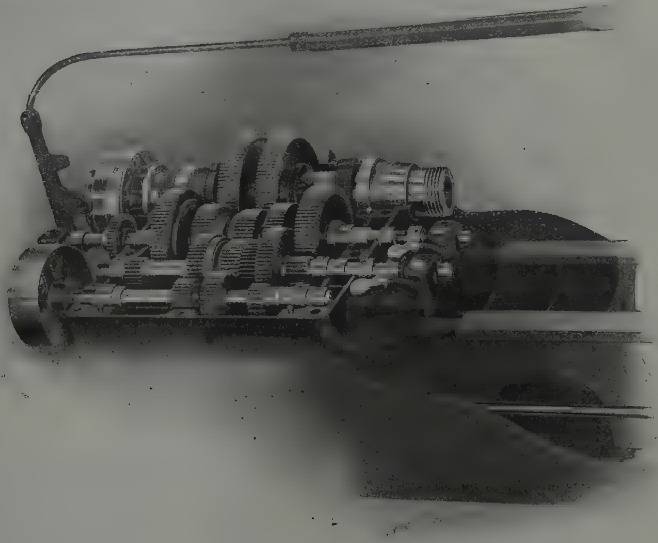
Two speed change levers, operating double friction clutches, with positive slow drive in neutral.

Arrangement gives nine spindle speeds, any one of which may be obtained while the machine is running *under cut.*

This is important. The operator can and will change speed whenever necessary to get greater production. even in such cases as speeding up a facing cut as the tool approaches the center.

Watch the operator on a machine when it is necessary to stop or slow down before changing speeds. Observation will convince.

The Hartness Flat Turret Lathe has a speed for every cut and that speed instantly obtained without stopping the cut.



JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

503 Market St., SAN FRANCISCO, CAL. 109 Queen Victoria St., LONDON, ENGLAND

AGENTS

France, Spain and Belgium—F. Auberty & Co., 91 Rue de Maubeuge, Paris.

Holland—Spliethoff, Beeuwkes & Co., Rotterdam.

Japan, Korea, etc.—Mitsui & Co., Ltd., Tokio.

Australasia—McPherson's Pty. Ltd., 554 Collins St., Melbourne.

SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

ENGINEERING INDEX (Continued)

List compiled from reports of manufacturers in April 1920, and arranged alphabetically under names of manufacturers.

British

The Marine Engine as Great Britain Has Developed It, M. W. Bourdon. Automotive Industries, vol. 42, no. 17, April 22, 1920, pp. 951-955, 15 figs. Review of British practice based on models exhibited at Olympia Show.

Corrosion, Prevention of

Preventing Corrosion in Marine Boilers, F. N. Speller, E. G. Bashore, Isaac Harter and W. W. Smith. Int. Mar. Eng., vol. 25, no. 5, May 1920, pp. 421-426, 3 figs. Survey of practice.

Heavy-Oil

Marine Heavy-Oil Engine Installation Practice and Development Possibilities, Hubert C. Verhey. Jl. Soc. Automotive Engrs., vol. 6, no. 5, May 1920, pp. 344-351 and (discussion) pp. 351-360, 9 figs. Popular exposition of working principles of types of two and four-cycle engines now in actual operation in cargo ships.

[See also DIESEL ENGINES; Gasoline Engines, British Marine; Internal-Combustion Engines. Olympia Show.]

MARINE STEAM TURBINES

Geared

Geared Turbines for Standard Ships of the N. 1 Class. Shipbuilder, vol. 22, no. 116, April 1920, pp. 234-239, 7 figs. Turbines designed for normal maximum output of 2300 s.hp. with provision for overload to 2900 s.hp. with dry saturated steam at 190 lb. per sq. in. and vacuum of 28 in., barometer standing at 30 in. They are of multi-stage impulse type and have high-pressure and low-pressure units in separate casings.

METAL WORK

Inlaid Work

A New Art Industry, Eugen Werner. Metal Industry (Lond.) vol. 16, no. 15, April 9, 1920, pp. 285-286 and p. 296. Possibility of instituting mass production of inlaid metal work is discussed. Translated from Galvanoplastite und Metallbearbeitung.

METALS

Grease Removal

Ethylene Trichloride as Grease-Removing Medium in the Metalware Industry (Trichloräthylen als Entfettungsmittel in der Metallwaren-Industrie), E. Krause. Das Metall, vol. 1919, no. 22, Nov. 25, 1919, pp. 301-303, 1 fig. Chlorated hydrocarbons were used during the war as substitutes for benzine, benzol, petroleum, etc., for removing grease from ground or polished metal parts, and of these C_2HCl_3, commonly called "tri," has proven most valuable and has the advantage over benzine and pertoleum of being fire- and explosion-proof. Description of process and apparatus used in this connection.

METEOROLOGY

Action Between Sea and Atmosphere

Temperature Variations in the North Atlantic Ocean and in the Atmosphere, Björn Helland-Hansen and Fridtjof Nansen. Smithsonian Misc. Coll., vol. 70, no. 4, 1920, 408 pp., 112 figs. Investigations of action which thermal condition of ocean exercises upon air circulation and air temperature.

Atmosphere, Ice Crystals in

Shape of Crystals Formed in Atmosphere (Sur la forme primitive de la glace atmosphérique), Louis Besson. Comptes rendus des Séances de l'Academie des Sciences, vol. 170, no. 10, March 8, 1920, pp. 607-609. From considerations based on formation of halos it is concluded that inclination of truncatures in ice crystals formed in atmosphere is 25 deg. 14 min. 4 sec.

Atmosphere, Upper Layers of

Relation Between the Movements and the Temperatures of the Upper Layers of the Atmosphere (Sur la relation entre les mouvements et les températures des hautes couches atmosphériques), V. Bjerknes. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 10, March 8, 1920, pp. 604-606. Theory is advanced that in lower layers of atmosphere temperature increases from poles to equator, and in upper layers temperature increases from equator to poles. Reasoning is based on equation for equipotential surface in atmosphere resulting from gravitational attraction and centrifugal force.

Temperature of the Upper Layers of the Atmosphere (Sur la température des hautes couches atmosphériques), V. Bjerknes. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 12, March 22, 1920, pp. 747-750. Temperature of atmospheric layers above cyclones and anti-cyclones is calculated from differential equation expressing temperature conditions of surface of separation between stratosphere and troposphere.

METRIC SYSTEM

Arguments Against Adoption in U. S.

Inches versus Millimeters, Machy. (N. Y.), vol. 26, no. 8, Apr. 1920, pp. 715-719. Opinions of engineers and manufacturers in machine-building trade who are unanimously for retention of present system: What a Change of Measures Would Mean, James Hartness; The Threat of the Metric System, Henry D. Sharpe; The English versus the Metric System, C. H. Norton.

Some effects of "Compulsory" Use of the Metric System, C. C. Stutz. Am. Mach., vol. 52, no. 13, Mar 25, 1920, pp. 693-694. Among effects mentioned are long transition period, introduction of dual system, confusion between two systems, cost "appalling in its magnitude," and recalculation and establishing of new prices.

English System vs.

Pan-Americanism in Weights and Measures, Frederick A. Halsey. Am. Mach., vol. 52, no. 15, April 8, 1920, pp. 784-786. Experiences of countries where Metric System has been adopted are surveyed and because "attempt to adopt the Metric System is a failure" it is suggested that English system be adopted as standard by all nations of American continents.

MILLING

Indexing Fixtures

Indexing Milling Fixtures—III. Machy., (N. Y.), vol. 26, no. 8, Apr. 1920, pp. 721-724, 7 figs. Notes on vertical feed milling attachment, hobbing worm-wheels on a milling machine, roughing out teeth of bevel-gear blanks, milling grooves in steel forgings, and fluting hollow milling cutters.

MILLING MACHINES

Crankshaft

Designs New Miller for Crankshafts. Iron Trade Rev., vol. 66, no. 10, Mar. 4, 1920, p. 713, 2 figs. Machine carries two motor-driven, inserted-tooth cutters that mill both sides of crank simultaneously. It is manufactured by Newton Machine Tool Works, Inc., Philadelphia.

Testing

Testing Methods Employed at the Becker Milling Machine Co.'s Plant, E. L. Dunn. Am. Mach., vol. 52, no. 16, April 15, 1920, pp. 833-835, 9 figs. Methods used for testing relation of knee and stand, correctness of knee bearing with angle bearing, alignment of column face with spindle, etc.

MINE HOISTING

See HOISTS, Electric.

MINE LOCOMOTIVES

Gathering Engine

Gathering Locomotive with New Features to Lengthen Life and Save Power, John Liston. Coal Age. vol. 17, no. 19, May 6, 1920, pp. 895-898, 6 figs. Features described are electric braking, outside frame with high track clearance, leaf-type springs, improved cable reel and demountable tires.

MINERS' LAMPS

Electric

Some Recent Improvements in Miners' Electric Lamps, William Maurice. Trans. Instn. Min. Engrs., vol. 59, part 1, March 1920, pp. 2-14 and discussion pp. 14-19, 14 figs. Among improvements quoted are electric lamp with acid accumulator. having contact plate mounted on porcelain base, miners' lamp with nickel-cadmium accumulator, and Wolf miners' alkaline lamp.

MINES

Safety Work

Directing and Caring for Men at Mines, M. D. Cooper. Coal Industry, vol. 3, no. 4, April 1920, pp. 180-182. Purpose and organization of National Safety Council, with special reference to its activities in Pittsburgh coal field.

Trolley Wiring

Correct Method for Trolley Wiring Mines—II, M. W. Beddow. Coal Age, vol. 17, no. 18, April 20, 1920, pp. 844-848, 19 figs. Standard methods of hanging curves and placing frogs, section insulators, anchors, protection boards and wire splices.

[See also GAS ENGINES, German Mine Plants.]

MINING

Shot Firing, Electric

Electric Shot Firing—II, MM. Taffanel, Dautriche, Durr and Perrin. Colliery Guardian, vol. 119, no. 3093, April 9, 1920, pp. 1009-1011, 7 figs. Description of various types of exploders used in shot firing, specially types mentioned in French permitted list for use in fiery mines. Translated from Annales des Mines.

MOTION-PICTURE PHOTOGRAPHY

Natural-Color

Cinematographic Pictures in Natural Colors, by Gaumont Trichromatic Process (Le cinématographe en couleurs naturelles par le procédé trichrome Gaumont), A. Bidault des Chaumes. Génie Civil, vol. 76, no. 10, Mar. 6, 1920, pp. 245-251, 31 figs. Photographic camera for taking pictures has three objectives, each of which is provided with filtering colored glass, the three colors being complementary. Three pictures are taken and later exposed on screen simultaneously, camera for exposing films being designed with three objectives disposed to permit exact merging of images. Objectives in exposure camera also carry filtering colored lenses. The three pictures are located lengthwise in film, so each successive exposure involves passage of three pictures, but size of each picture is smaller than in ordinary film.

MOTOR-TRUCK TRANSPORTATION

Economic Status of Trucks

The Economic Place of the Motor Truck in the Nation's Transportation. Automotive Industries, vol. 42, no. 20, May 13, 1920, pp. 1122-1123. Survey of uses to which motor trucks have been put and visualization of their future expansion.

MOTOR TRUCKS

Commer

A New 2-Ton Commer Car. Motor Traction, vol. 30, no. 791, Apr. 26, 1920, pp. 407-410, 7 figs. Particulars: Engine, four cylinders, 100 x 120 mm.; carburetor, Claudel-Hobson; speeds, three; drive, overhead worm.

Pneumatic vs. Solid Tires

Relation of Solid and Pneumatic Tires to Motor-Truck Efficiency, S. V. Norton. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 208-214. Factors considered are those involved in engineering design and those resulting from practical limitations by reason of requirements of service. Opinion is expressed that in spite of present progress, question of using pneumatic tires on trucks should not overshadow study of other means than tires to develop cushion effects.

Tests Reveal Relative Values of Pneumatic and Solid Tires, Alfred F. Masury. Eng. News-Rec., vol. 84, no. 14, April 1, 1920, pp. 668-670, 2 figs. Motion-picture studies made by International Motor Co. It is concluded that impact of truck striking ground after bounding over an obstruction is increased approximately as square of speed and as weight; but inversely as resiliency of springs and tires. Tests are described in detail and it is seen, for example, in one case, that pneumatic saved road two-thirds "grief" and vehicle itself one-fourth.

Specifications

Motor Truck Specifications. Power Wagon, vol. 24, no. 186, May 1920, pp. 4566. Major specifications of internal-combustion and electric trucks grouped according to load rating and arranged alphabetically according to brand name.

Use in Railway Terminals

Removable Truck Bodies Save Labor, B. F. Fitch. Iron Trade Rev., vol. 66, no. 13, Mar. 25, 1920, pp. 924-925, 3 figs. Experience at Cincinnati Terminal of Big Four railroad.

[See also TERMINALS, MARINE, Tractors and Trailers.]

MOTORSHIPS

Converted Schooner

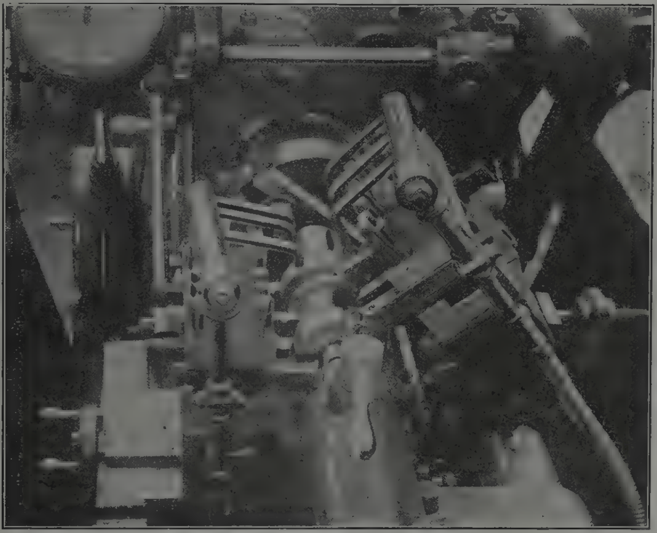
New Uses for Old Sailing Vessels. Int. Mar. Eng., vol. 25, no. 5, May 1920, pp. 393-394, 1 fig. Former British-built schooner Katherine converted into motor vegetable-oil tanker for American company.

Largest Yet Constructed

The Biggest Motor-Ship in the World. Shipbuilding & Shipping Rec., vol. 15, no. 18, April 29, 1920, pp. 572-575, 5 figs.; partly on supp. plate. Twin screw motorship "Afrika," built and engined by Burmeister & Wain, of Copenhagen, for the East Asiatic Co. Dimensions are: Length over all, 464 ft. 6 in.; length between perpendiculars, 445 ft.; breadth, moulded, 60 ft.; depth moulded to upper deck, 33 ft. 3 in.; gross tonnage, 8597 tons; net tonnage, 5468 tons; oil fuel capacity, 1500 tons; indicated horsepower, 4500.

FAY AUTOMATIC LATHE

Machining Triple Gear Blanks



The above photograph shows the machining of a triple gear on the Fay Lathe.

The back arm rocks in, faces the shoulder and cuts the grooves.

The front carriage rocks in and turns between gears and finishes outside diameter of gears.

This is an excellent example of multiple tooling—all the tools and feed that the work will stand.

The Fay Automatic Lathe stands alone as a producer of work of this kind.

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Australasia—McPherson's Pty. Ltd., 554 Collins St., Melbourne.

SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

ENGINEERING INDEX (Continued)

N

NATURAL GAS

Efficiency in Cooking

Efficiency of Natural Gas Used in Domestic Service, Robert F. Earhart. Mech. Eng., vol. 42, no. 5, May 1920, pp. 287-288 and 316, 4 figs. Results of tests on commercial burners under kitchen conditions, showing effect of gas pressure and distance between burner and vessel on the efficiency.

NAVIGATION

Radio Compass

The Prospective Utilization of Vessel-to-Shore Radio-Compass Bearings in Aerial and Transoceanic Navigation, G. W. Littlehales. Jl. Am. Soc. Naval Engrs., vol. 32, no. 1, Feb. 1920, pp. 38-44, 3 figs. Method is described for finding altitude and longitude in aerial and marine navigation from vessel-to-shore radio-compass bearings, and theory is explained upon which such method is based.

NITROGEN

Consumption in U. S.

Consumption of Inorganic Nitrogen in the United States, D. P. Gaillard. Chem. & Metallurgical Eng., vol. 22, no. 17, April 28, 1920, pp. 783-786, 1 fig. Attempt is made to forecast future consumption of inorganic nitrogen in the United States from examination of conditions during last twenty years.

Supply in U. S.

Supply of Inorganic Nitrogen in the United States, D. P. Gaillard. Chem. & Metallurgical Eng., vol. 22, no. 18, May 5, 1920, pp. 841-845, 1 fig. Summary of figures on consumption and supply showing deficiency even if government plants are operated.

O

OIL

Fractionation

Constant-Temperature Still Head for Light-Oil Fractionation, Frederick M. Washburn. Dept. Commerce, Technologic Papers, Bur. Standards, no. 140, Oct. 18, 1919, 12 pp., 4 figs. Types of methods generally in use for fractionation of light oil and determination of benzene, toluene and solvent naphtha are discussed and improvement is suggested of dephlegmator of Wilson and Roberts still.

[See also PETROLEUM.]

OIL ENGINES

Fuel Spraying

A Study of the Phenomena Observed in the Combustion Space of Oil Engines in Connection with Fuel Spraying (Erwägungen über die Vorgänge im Verbrennungsraum beim Einspritzvorgang), F. Ernst Bielefeld. Motorwagen, vol. 22, nos. 32 and 33, Nov. 20 and 30, 1919, pp. 614-620 and 631-635, 35 figs. Various existing theories explaining these phenomena are pronounced incorrect, and it is claimed phenomena can be explained by the assumption that the molecules represent very small bubbles. Requirements for effecting a perfect combustion are discussed.

[See also DIESEL ENGINES; KEROSENE ENGINES; MARINE ENGINES, Heavy-Oil.]

OIL FIELDS

Alsace

The Oil Fields of Alsace (Les gisements de pétrole d'Alsace), Paul de Chambrier. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 132, no. 1, Jan.-Feb. 1920, pp. 45-70, 9 figs. Mining and refining operations.

Northwest Germany and Roumania

The Petroleum Fields of Roumania Compared with Those of Northwest Germany (Die Erdöllagerstätten in Rumänien verglichen mit denen in Nordwestdeutschland), G. Gürich. Petroleum, vol. 14, no. 13, Apr. 1, 1919, pp. 597-601, 5 figs. Writer points out dissimilar features of the German and Roumanian oil fields, but claims, nevertheless, that a great similarity exists. Notes on the stratigraphy of the Roumanian oil territory and a geological sketch of Roumanian petroleum zone presented by Mrazec in 1907, along with report of investigations at the 3rd Petroleum Congress at Bucharest.

Ohio and Indiana

Rise and Decline in Production of Petroleum in Ohio and Indiana, J. A. Bownocker. Min. & Metallurgy, No. 158, Section 22, Feb. 1920, 12 pp., 2 figs. Geology of region and records of wells.

Pennsylvania-New York

A Résumé of the Pennsylvania-New York Oil Field, Roswell H. Johnson and Stirling Huntley. Min. & Metallurgy, No. 158, Section 23, Feb. 1920, 4 pp. Geological and stratigraphical notes.

OIL FUEL

Burners for

The Utilization of Oil Fuel in Industrial Furnaces (L'emploi des combustibles liquides dans les foyers industriels), F. Scoumanne. Revue générale de l'Électricité, vol. 7, no. 16, Apr. 17, 1920, pp. 527-536, 3 figs. Comparative study of various types of burners. (Concluded.)

The Wallsend-Howden System of Burning Liquid Fuel. Shipbuilding & Shipping Rec., vol. 15, no. 16, April 15, 1920, pp. 519-520, 5 figs. Liquid fuel is injected into furnaces under pressure through burner, where it is atomized. Burner is designed to force oil into furnace in shape of conical spray of fine particles, which burst into flame at distance of from 6 in. to 8 in. from nozzle.

Handling

Handling Heavy Oils at Locomotive Fuel Stations, J. L. Starkie. Ry. Age, vol. 68, no. 15, Apr. 9, 1920, pp. 1147-1148, 4 figs. Points out that tanks and pipe lines must be heated to obtain necessary fluidity in service installations. Describes how turns, bends and expansion joints are handled when steam pipes are placed inside oil pipes.

Russia

The Utilization of Liquid Fuel in Industrial Furnaces (L'emploi des combustibles liquides dans les foyers industriels), F. Scoumanne. Revue générale de l'Électricité, vol. 7, no. 15, Apr. 10, 1920, pp. 497-505, 16 figs. Furnaces used in Baku region, Russia, are illustrated and described, and transformations, which it is required to make in coal furnaces to adapt them to burning of oil fuel, are discussed. (To be continued.)

[See also BOILER FIRING, Oil-Fuel Installation.]

OIL TANKS

Protection Against Lightning

Protecting Oil Storage Tanks Against Lightning, Oliver Lodge. Nat. Fire Protection Assn., vol. 13, no. 3, Jan. 1920, pp. 241-244. Opinion is expressed that metal tanks, not over-elevated and not specially earthed, with good joints and free from leaks, "are as safe as anything can well be, provided the roof and other parts are examined from time to time from the point of view of corrosion." From Petroleum World.

OIL WELLS

Permits and Leases

Regulations Concerning Oil and Gas Permits and Leases (Including Relief Measures) and Rights of Way for Oil and Gas Pipe Lines. Dept. Interior, Gen. Land Office, no. 672, March 11, 1920, 38 pp. Rules and regulations prescribed for administration of provisions of act of Congress approved Feb. 25, 1920, entitled "An act to promote the mining of coal, phosphate, oil, oil shale, gas and sodium on the public domain."

OILS

Hardening of

Technical Application of Hydrogen in Hydrogenation or Hardening of Oils, Harry L. Barnitz. Chem. & Metallurgical Eng., vol. 22, no. 16, Apr. 21, 1920, pp. 745-748, 4 figs. Discussion of principles involved in saturating unsaturated oils by hydrogenation and commercial adaptability of method to industrial and edible oils; technology of process and schematic outline of apparatus used.

OPEN-HEARTH FURNACES

Design

Design of Furnaces and Ovens is Factor in Cutting Costs in New Open-Hearth Plant. Iron Trade Rev., vol. 66, no. 13, Mar. 25, 1920, pp. 915-920, 8 figs. Features of furnaces to which attention is particularly directed are cooling of furnace doors with running water and their operation by compressed air, which is controlled by valve centralized at one station near wall in front of furnace, charge being brought from stock yard in charging boxes carried on flat-bottom cars, and complete record being kept of every heat.

Waste-Heat Utilization

Using Waste Heat from Furnaces, B. H. Greene. Iron Trade Rev., vol. 66, no. 15, Apr. 8, 1920, pp. 1065-1068, 3 figs. Installation where steam derived from waste heat is supplemented by coal-fired boilers and used for electric power generation. Paper read before Cleveland Section, Assn. Iron and Steel Elec. Engrs.

OSCILLATIONS

Damped

Damped Oscillations in Coupled Circuits, G. Bamwell Ehrenborg. Radio Rev., vol. 1, no. 7, April 1920, pp. 329-336, 6 figs. Mathematical study. (Continuation of serial.)

Electric and Acoustic

Determination of the Frequency of Acoustic and Electric Oscillations with the Aid of the Beat Method (Ueber die Bestimmung von Schwingungzahlen akustischer und elektrischer Schwingungen mit Hilfe der Schwebungsmethode), R. Weller. Jahrbuch der drahtlosen Telegraphie und Telephonie, vol. 14, no. 6, Nov. 1919, pp. 599-608, 3 figs. Methods in use for determining frequency of acoustic and electric oscillations are described as (1) comparison with monochord by means of beats, (2) excitation of stationary vibration in tubes according to Kundt and Quincke, and (3) determination of length of waves of an electric vibration circuit from self-induction and capacity according to the Thomson formula. To these, writer adds a method for determining vibration frequency by use of tube transmitters which, though not as exact as above mentioned methods, is said to be useful and serviceable for simple and rapid control. Report from the Laboratory of the Technical Department for Wire Apparatus, Jena.

OXY-ACETYLENE WELDING

Locomotive Cylinders

Welding a High-Pressure Cylinder, Frank H. Frye. Welding Engr., vol. 5, no. 4, April 1920, pp. 28 and 32, 4 figs. Welding of high-pressure cylinder of Mallet Articulated Class AE Locomotive by Oxweld Acetylene process.

Pipe Joints

Oxyacetylene Gas Welding, Alfred S. Kinsey. Gas Age, vol. 45, no. 8, Apr. 26, 1920, pp. 331-335, 10 figs. Laying of pipe line near Philadelphia. Line is of standard 12-in. and 16-in. steel pipe, being double-piped for three miles and single-piped for five miles. Pipe joints were welded by oxyacetylene process.

P

PAINT OILS

Fume Loss in Boiling

Fume Loss in Boiling Oils, Henry A. Gardner and Harold Parks. Paint Manufacturers' Assn. of U. S., circular no. 95, May 1920, 3 pp. Tables showing experimentally determined fume loss of six oils when heated at varying temperatures for different periods of time.

PAINTING

Spray Method

Spray Painting, H. A. Gardner. Sci. Am. Monthly, vol. 1, no. 4, April 1920, pp. 335-336, 6 figs. Study of practicability of blowing paint on various surfaces.

PAINTS

Thinners for

Notes on the Standardization of Mineral Spirits, Henry A. Gardner. Paint Manufacturers' Assn. of U. S., circular 94, May 1920, 3 pp. Rules are suggested for standardization of turpentine and other mineral oils used for thinning paints and varnishes.

PATTERN-MAKING

Canal Zone Shops

The Pattern Shop at Balboa, R. D. Gatewood. Am. Mach., vol. 52, no. 14, April 1, 1920, pp. 723-725, 6 figs. Balboa shops of Panama Canal.

PATTERNS

Storage of

Safe Storage of Patterns, J. V. Hunter. Am. Mach., vol. 52, no. 17, April 22, 1920, pp. 901-902, 5 figs. Experience of Minneapolis Threshing Machine Co., which has built fireproof pattern-storage building to house what is estimated to be one million dollars worth of patterns.

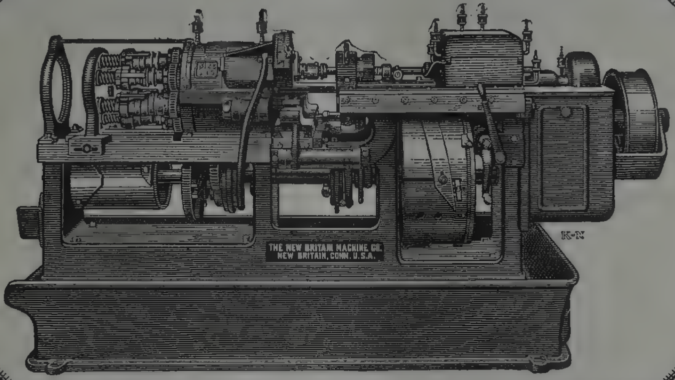
PAPER MILLS

Electric Drive

The Electric Drive in Paper Mills, E. Tanner and C. F. Papworth. Elecn., vol. 84, no. 2184, March 26, 1920, pp. 344-348, 5 figs. Description of paper mill in south of England, having average weekly output of 1500 tons of paper.

100-Ton Mill

Large Pulp and Paper Mill Development by International Paper Co. at Three Rivers, Romeo Morrissette. Contract Rec., vol. 34, no. 15, Apr. 14, 1920, pp. 338-340, 3 figs. Description of 100-ton-per-day sulphite mill which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PATENT LAWS

Needed Improvements

Needed Improvements in Our Patent Office and System, Glenn B. Harris. Am. Mach., vol. 52, no. 15, April 8, 1920, pp. 798-803. Comments on Patent Bill 11,984.

PAVEMENTS, ASPHALT

Sheet Asphalt

New Design for an Asphalt Road, Hugh J. Fixmer. Public Works, vol. 48, no. 13, April 24, 1920, pp. 362-364, 5 figs. Design is proposed for using sheet asphalt with concrete shoulders on highways; also for constructing this in successive half-width sections.

Specifications for

Asphalt in Road Consruction, Jules L. Goldberg. Public Roads, U. S. Dept. Agriculture, Bur. Public Roads, vol. 2, no. 18-19, Oct.-Nov. 1919, pp. 3-12, 4 figs. Bureau of Public Roads' specifications for different types of asphalt pavements.

PAVEMENTS, BITUMINOUS

Roller for Tamping Concrete Base

New Developments in Construction of Bituminous Concrete Pavements, Theodor S. Oxholm. Mun. & County Eng., vol. 58, no. 4, April 1920, pp. 150-151, 1 fig. Corrugated roller used for tamping screenings of concrete base of bituminous pavements in Borough of Richmond, City of New York.

PAVEMENTS, BRICK

Filler, Asphalt for

Recent Experience in the Development of Brick Pavement Construction in the City of Chicago, H. J. Fixmer. Mun. & County Eng., vol. 58, no. 4, April 1920, pp. 147-149, 1 fig. Service records of pavements with different kinds of fillers are presented. It is stated that as result of experience during recent years Board of Local Improvements has adopted asphalt filler as standard filler for brick pavements in streets and alleys.

PAVEMENTS, CONCRETE

See ROADS, CONCRETE, Design and Construction.

PAVEMENTS, WOOD-BLOCK

Contraction of

Wood Block Pavement Fails Through Contraction and Flotation, W. W. Horner. Eng. News-Rec., vol. 84, no. 17, April 22, 1920, pp. 814-817, 1 fig. It is reported that section of pavement in street in St. Louis, Mo., was destroyed and another section suffered damage because of contraction of blocks and their flotation due to melted pitch.

PEAT

Classification of

Quality and Value of Important Types of Peat Material, Alfred P. Dachnowski. Jl. Am. Peat Soc., vol. 13, no. 2, April 1920, pp. 219-261. Classification of peat based upon its botanical composition and physical and chemical characteristics. Reprint of bulletin 802, U. S. Dept. of Agriculture.

PETROLEUM

Refining

Spent Lyes and Waste Waters in Petroleum Refining (Die Abfallaugen und Abfallwässer der Erdöverarbeitung), Fred. Schulz. Petroleum, vol. 14, nos. 14 and 15, Apr. 15 and May 1, 1919, pp. 644-658 and 711-718, 1 fig. It is pointed out that the spent lye escaping along with the viscous emulsions and wash water when alkaline purification of the petroleum distillates takes place, contains, besides the inorganic salts, soda soaps of the carboxylic acids which are insoluble in water and sulphonic acids in addition to neutral hydrocarbons. The removal of organic matter, it is said, can be successfully accomplished only with cooking salt. Report from Inst. for Indus. Advancement of Chamber of Commerce & Industry at Prague.

The Regeneration of Waste Acids in Mineral Oil Refineries (Die Regenerierung von Abfallsäuren der Mineralölraffinerien), E. A. Kolbe. Petroleum, vol. 14, no. 17, June 1, 1919, pp. 837-847, 5 figs. Results of experiments are said to show that by simply heating it is possible to recover almost 90 per cent of the sulphuric acid contained in the waste acids of the refining process, mainly in form of sulphur dioxide. Description and illustration of the Rossi revolving head used in tests for spraying the waste acids.

[See also OIL FIELDS.]

PETROLEUM INDUSTRY

International Aspect

International Aspects of Petroleum Industry, Van H. Manning. Min. & Metallurgy, No. 158, Section 24, Feb. 1920, 10 pp. Attention is called to strong nationalistic tendency of foreign countries to exclude other nationals from developing oil fields, and to rapidly diminishing petroleum supply in United States.

PIPE, CONCRETE

See also SEWERS, Concrete, Specifications for.

PIPE LINES

Design of

The Hydraulics of Oil Pipe Lines, W. F. Durand. Jl. Electricity, vol. 44, no. 9, May 1, 1920, pp. 434-439, 1 fig. Formula expressing loss of head in terms of length and diameter of pipe line, velocity of flow, and viscosity and density of liquid, is discussed and interpreted.

PLYWOOD

See AUTOMOBILES, Plywood.

PRODUCTION

Ford Methods

Ford Production Methods, Thomas Gorst, Eng. & Indus. Management, vol. 3, no. 15, April 8, 1920, pp. 451-455, 1 fig. Important detail of system is organization whereby hourly reports come into works superintendent from all departments, these being tabulated and recorded in such a way as to indicate immediately any department which shows signs of falling behind.

Lincoln Motor Plan

The Lincoln Motor Production Plan—II, I. J. Beatty. Factory, vol. 24, no. 4, Mar. 1, 1920, pp. 623-626, 5 figs. Records of receiving, manufacturing, and shipping.

Methods of

Modern Production Methods—I and II, W. R. Basset. Am. Mach., vol. 52, nos. 15 and 17, April 8 and 22, 1920, pp. 761-764 and 873-876, 6 figs. Importance of careful advanced planning of production is pointed out. Discusses purchasing as a tool of production; describes and contrasts different methods of buying.

Organizing for

Putting Across a Campaign for Greater Production. Factory, vol. 24, no. 7, Apr. 15, 1920, pp. 1133-1137, 3 figs. Experience of National Cash Register Co. in introducing plan which is said to have turned a 32 per cent slump in output into increase over previous records.

[See also LABOR, Great Britain.]

PROPELLERS, SHIP

Performance

Estimates of Propeller Performance from Self-Propelled Model Tests, William McEntee. Int. Mar. Eng., vol. 25, no. 5, May, 1920, pp. 417-420, 4 figs. Method developed and used at Washington Model Basin and the comparative results of model tests and ship trials of U. S. S. New Mexico.

PULVERIZED COAL

Italian Locomotives, Use in

Pulverized Coal for Italian Locomotives. Ry. Age, vol. 68, no. 19, May 7, 1920, pp. 1363-1364, 3 figs. Description of equipment designed for Italian State railways to utilize native low-grade lignites.

Melting Iron with

Melting Iron with Powdered Coal. Iron Trade Rev., vol. 66, no. 9, Feb. 26, 1920, pp. 627-630, 4 figs. Installation of unloading, crushing, drying, conveying and burning system for using pulverized coal in malleable air furnace. Equipment manufactured under patents held by Combustion Economy Corp.

Plants

United States Nitrate Plant No. 2, J. B. Gaffney. Cement, Mill & Quarry, vol. 16, no. 8, April 20, 1920, pp. 15-20, 8 figs. Pulverized coal plant and rotary kiln lime plant which it served as part of ammonium nitrate plant built by Air Nitrates Corporation, Muscle Shoals, Ala.

[See also ROLLING MILLS, Sheet Mill.]

PUMPING

Gasoline vs. Electricity

Comparison of Gasoline and Electric Pumping, H. R. Turner. Public Works, vol. 48, no. 14, Apr. 17, 1920, pp. 322-324, 3 figs. Pump at water works of Windsor, Conn., it is said, is operated by electricity 20 per cent more economically than by gasoline.

PUMPS

Air-Lift

Experiences with Air Lift Pumps, W. G. Kirchoffer. Mun. & County Eng., vol. 58, no. 4, April 1920, pp. 177-184, 5 figs. Out of comparative tests in which gals. per min. pumped and submergences were equal for each nozzle, 40 per cent are reported to have resulted in favor of straight nozzle by average of 0.024444 cu. ft. of air per gal.

PYROMETERS

Radiation

Investigation of Two Radiation Pyrometers (Untersuchung zweier Strahlungspyrometer), G. Berndt. Dinglers Polytechnisches Jl., vol. 334, nos. 24 and 25, Nov. 29 and Dec. 13, 1919, pp. 269-274 and 281-286, 5 figs. Details and comparison of Féry and Braun pyrometers. The main advantage of radiation over optical pyrometers is said to be that former permit of registration of temperature and remote observation; but writer claims there are a number of disadvantages in the Féry and Braun instruments, which he discusses separately. Report from physical laboratory of the C. P. Goerz Co.

R

RADIO COMMUNICATION

Aircraft Radio Sets

Radio Apparatus for Aircraft and Ground Stations, E. M. Kinney. Proc. Engrs. Soc. Western Pennsylvania, vol. 36, no. 1, Feb. 1920, pp. 1-21 and discussion pp. 22-24, 13 figs. Aircraft radio sets manufactured for the Navy by the General Electric Co.

RADIOMETALLOGRAPHY

Procedure

Contrast and Exposure in X-Ray Photographs Through Metals, R. E. Slade. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 52-59, 3 figs. Discusses efficiency of photographic plate as detector and what may be expected from it in the light of present knowledge of X-rays and photographic processes.

The Principles Governing the Penetration of Metals by X-Rays, G. Respondek. Trans. Faraday Soc., Appendix, vol. 15, part 2, Feb. 1920, pp. 45-64, 8 figs. Suggestions in regard to practical application of X-rays to investigation of metals.

The Apparatus and Procedure of Radiometallography, M. Hector Pilon and Geoffrey Pearce. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 47-51, 10 figs. on 4 supp. plates. Illustrations are presented showing industrial applicability of radiometallography. Writers state that they have succeeded in penetrating steel 50 to 55 mm. thick by X-ray apparatus in conjunction with Coolidge tube.

Research

Investigation of Metals by Means of X-Rays, Frederick Janus and Max Reppchen. Trans. Faraday Soc., Appendix, vol. 15, part 2, Feb. 1920, pp. 2-44, 38 figs. Account of investigations carried out in Munich in the "Scientific Laboratory" and in the "X-Ray Research Establishment" of the Reiniger, Gebbert and Schall A. G., of Berlin Erlangen. Among subjects investigated was locating depth at which faults were situated in specimens.

Researches Into the Industrial X-Ray Examination of Metals at the Laboratories of Messrs. Schneider, Le Creusot, E. Schneider. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 32-34, 10 figs. on 4 supp. plates. Radiographs are given of plates of various thicknesses. It is stated that application of radiometallography enables visual examination to be made of ordinary steels of thicknesses up to 45 mm.

X-Ray Shadow Photography

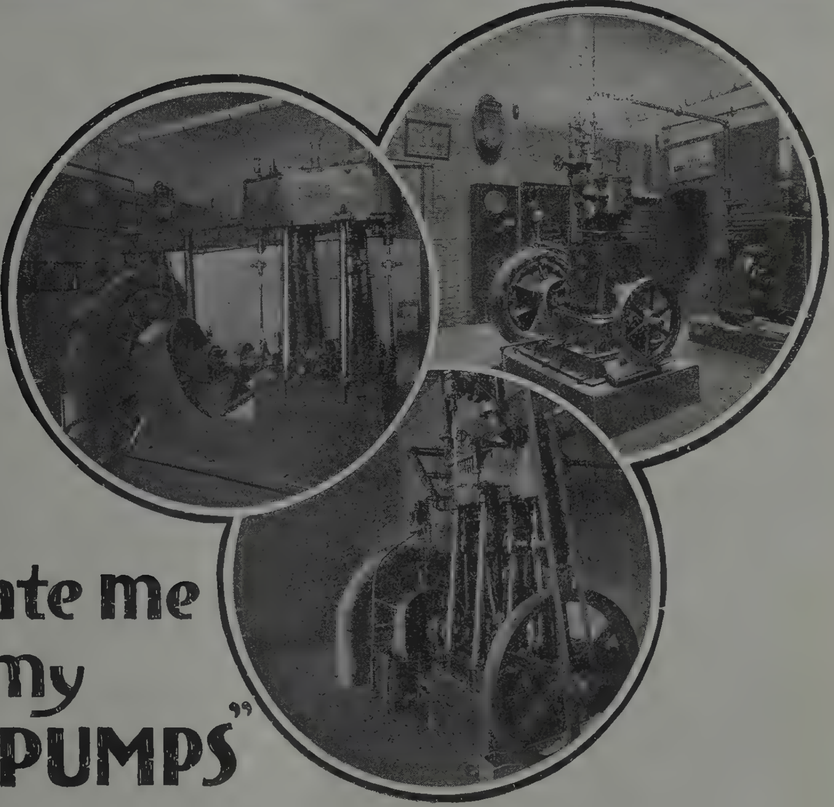
The Examination of Materials by X-Rays, W. H. Bragg. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 25-31, 10 figs. on 4 supp. plates. Use of X-ray shadow photography is explained and photographs are presented of various machine parts and their interpretation given.

RADIOTELEGRAPHY

Musical Notes, Reception of

Musical Reception with Continuous Waves Without Local Oscillations, L. W. Austin. Jl. Washington Acad. Sciences, vol. 10, no. 8, April 19, 1920, pp. 223-226, 2 figs. Diagram of connections for toothed-wheel contact maker, provided with brush bearing on face of wheel or axle in such a way as to produce steady

MORRIS



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ENGINEERING INDEX (Continued)

contact, while second brush is adjusted so as to touch the teeth. It is said that with this arrangement reception of musical notes can be obtained with continued oscillations.

Radiation Fields

The Quantitative Determination of Electromagnetic Radiation Fields in Wireless Telegraphy (Ueber die quantitative Bestimmung elektromagnetischer Strahlungsfelder in der drahtlosen Telegraphie), Heinrich Rausch von Traubenberg. Jahrbuch der drahtlosen Telegraphie und Telephonie, vol. 14, no. 6, Nov. 1919, pp. 569-578, 3 figs. Notes on direct and indirect methods both in connection with derivation of the theoretic principles and in practical measurements. Application of indirect method is said to be more complicated and more subject to errors than the direct method, but, on the other hand, can be used for measurement of much smaller fields. Results of measurement of magnetic fields at the Nauen station showed that for measuring at distance of 120 km. indirect method only can be used. Writer mentions that preliminary experiments suggest possibility of determining fields of American stations in Europe. Report from the Laboratory of the Wireless Telegraphy Co. in Berlin.

Receivers

Measuring and Comparing Intensities of Wireless Telegraphy Receivers (Mesure et comparaison des intensités dans les récepteurs de télégraphie sans fil). Revue générale de Électricité, vol. 7, no. 10, March 7, 1920, pp. 325-328, 2 figs. Method suggested consists in producing equalization of current to be measured and an auxiliary current of the same frequency and form, created by small emitter, the inductive action of which upon the reception can be varied by operator between known limits by progressive steps. Equalization of currents is effected by means of a telephone receiver.

Stations

Wireless Communication Stations as Competitors of Wire and Cable Telegraphy (Drahtlose Verkehrsstationen als Konkurrenz für Draht- und Kabeltelegraphie). Eugen Nesper. Jahrbuch Zeitschrift für drahtlose Telegraphie u. Telephonie, vol. 15, no. 1, Jan. 1920, pp. 69-72, 1 fig. Writer describes technical equipment required for such stations.

[See also AMPLIFIERS; Oscillations; Triode Valves.]

RAILS

Fracture

One of the Causes of Rail Fracture, and a Way of Preventing It, Georges Charpy and Jean Durand. Bul. Int. Ry. Assn., vol. 2, no. 1-2-3, Jan.-Feb.-March 1920, pp. 45-48, 5 figs. Fine cracks which are formed in course of time on rolling surface of rails are attributed, as result of experimental investigation, to intense crushing to which superficial layer of rail is subjected. This phenomenon is said to be common to other objects, such as chains, bolts, stays, etc. It is said that this effect can be counteracted by annealing treatment applied to surface at suitable intervals. Translated from Comptes rendus des Séances de l'Académie des Sciences.

Specifications

Report of Committee IV—On Rail. Bul. Am. Ry Eng. Assn., vol. 21, no. 225, March, 1920, pp. 225-266, 19 figs. Specifications for carbon-steel rails are formulated. One appendix enumerates results of experiments made to determine nature of defects revealed by deep etching of transversely fissured rails, and another discusses brittleness in steel rails.

Wear

Cause of Undulatory Wear of Rails (Cause de l'usure ondulatoire des rails), Ch. Frémont. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 14, Apr. 6, 1920, pp. 837-838. Explanation given is as follows: When a wheel slides on rail, axle of wheel is strained by resisting torque; when wheel comes to sudden stop energy of torsion in axle is suddenly released and wheel is caused to rotate slightly in opposite direction, thus grinding rail.

RAILWAY OPERATION

Automatic Control Systems

Regan Automatic Train Control System C. R. I. & P. Ry. Ry. Rev., vol. 66, no. 18, May 1, 1920, pp. 720-723, 6 figs. System is of intermittent contact type and is designed to carry continuous speed control through caution territory. It embraces both automatic speed control and automatic stop features.

Freight-Train Loading Method

A Practical Freight Train Loading Method, R. S. Mounce. Ry. Mech. Eng., vol. 94, no. 5, May, 1920, pp. 270-274, 5 figs. Method is outlined for finding car factor and equated loading for any given condition. Basis of method is standard loading chart for 10,000-lb. available tractive effort at speeds between 5 and 12 m.p.h. under various weather conditions.

Signal Indications

Train Operation by Means of Signal Indications, F. H. Bagley. Ry Signal Engr., vol. 13, no. 5, May, 1920, pp. 208-210, 6 figs. Automatic signals operating an overlap scheme, together with time block and written orders, it is said, have controlled traffic for past eight years over stretch of single track of Louisville & Nashville Railroad.

Single-Track

Single Track Operation Without Train Orders, F. H. Bagley. Ry. Age, vol. 68, no. 16, Apr. 16, 1920, pp. 1205-1206, 2 figs. Busy stretch operated by signal indication by installation of traffic locking scheme.

Speed Control

Rock Island Installs Speed Control and Train Stop. Ry. Signal Engr., vol. 13, no. 5, May, 1920, pp. 204-206, 5 figs. Three-position relay repeats signal indications. Passing of caution signals restricts speed.

[See also SNOW PLOWS.]

RAILWAY SIGNALING

Melbourne

Signaling On Melbourne Electrified Railways, F. M. Calcutt. Ry. Signal Engr., vol. 13, no. 5, May 1920, pp. 184-198, 11 figs. Three-position automatic signaling is used. From Indus. Australian and Min. Standard.

Radio Signaling

Augereau Wireless System of Railway Signaling (Le système Augereau pour la répétition des signaux sur les locomotives), Revue générale de l'Électricité, vol. 7, no. 15, Apr. 10, 1920, pp. 506-507, 3 figs. Apparatus for reproducing in locomotive cab by means of Hertzian waves signals usually indicated along track. This system has been tried successfully, it is said, by French State Railways.

RAILWAY TRACK

Concrete Roadbed

Concrete Roadbed for Track, Tunnels and Stations. Eng. News-Rec., vol. 84, no. 17, April 22, 1920, pp. 826-828, 9 figs. Experience of various railways is quoted in securing increased stability and decreased maintenance by using concrete slab base under railway track. From report of Ballast Committee of Am. Ry. Eng. Assn.

Maintenance

Maintenance Cost Reduced by Pneumatic Tie Tampers, W. H. Armstrong. Compressed Air Mag., vol. 25, no. 4, April 1920, pp. 9604-9609, 25 figs. Based on records of performances of tie tamping machines obtained by U. S. Railroad Administration.

Stresses in

Second Progress Report of the Special Committee to Report on Stresses in Railroad Track. Proc. Am. Soc. Civil Engrs., vol. 46, no. 2, Feb. 1920, pp. 133-304, 100 figs. Report of joint committee of Am. Soc. of Civil Engrs. with Am. Ry Eng. Assn. It is concluded from results obtained in numerous tests with different types of engines that action of driving-wheel counterbalance multiplies static load stresses in rail. In some cases excess stress chargeable to unbalance is much more than static rail stress. Nature of service given by tie is defined by measurements of tie bending and distribution of rail load to ballast.

[See also SCALES, Track.]

RAILWAYS, MILITARY

Light Railways, French Battle Front

The "Light Railways" of the Battle Front in France, Frank G. Jonah. Proc. Am. Soc. Civil Engrs., vol. 46, no. 1, Jan. 1920, pp. 81-98, 20 figs. partly on 4 supp. plates. Types of "light railways" built at the front by American, French, English and German troops.

RANGE FINDERS

Naval, Accuracy of

Range Finders and Range Finding, F. J. Cleary. Jl. Am. Soc. Naval Engrs., vol. 32, no. 1, Feb. 1920, pp. 1-37, 25 figs. Notes on accuracy of range finders employed in naval service and suggestions in regard to care that must be exercised in handling them.

RECTIFIERS

Voltage Multiplication

Establishment of a Continuous-Current Voltage which is a Multiple of the Alternating Voltage Employed without Using a Transformer (Erzeugung einer Gleichspannung vom vielfachen Betrage einer Wechselspannung ohne Transformator), H. Greinacher. Schweiz. Elektrotechnischer Verein, Bul., vol. 11, no. 3, Mar., 1920, pp. 59-66, 6 figs. Reference is made to system for transforming alternating current into constant continuous current previously described by which continuous-current voltage is delivered of double the value of the alternating-current voltage. Writer claims he has now succeeded in tripling the voltage by the use of condensers and valve cells, and theoretically, at least, established possibility of multiplying voltage to any desired extent.

[See also THERMIONIC VALVES.]

REFRACTORIES

Magnesite

Magnesite Refractories, J. Spotts McDowell and Raymond M. Howe. Jl. Am. Ceramic Soc., vol. 3, no. 3, March 1920, pp. 185-246, 5 figs. Survey of development of magnesia refractories in steel making, with notes on crude magnesite and the manufacture of magnesite bricks, as well as enumeration of properties of caustic, dead-burned and fused magnesia. Photomicrographs of magnesia brick are included, and also biography of magnesite and magnesite brick.

Sillimanite

The Commercial Synthesis of Sillimanite, Andrew Malinovszky. Chem. & Metallurgical Eng., vol. 22, no. 18, May 5, 1920, pp. 851-853, 3 figs. Cupola process for fusing alumina and silica to form sillimanite crystals. Reactions consist of forming carbides under reducing, and combusting them under oxidizing conditions.

RELATIVITY

Theory of

The Impossibility of Employing Mechanical Models to Illustrate the Relativity Theory (Die Unmöglichkeit mechanischer Modelle zur Veranschaulichung der Relativitätstheorie), J. Petzoldt. Berichte der physikalischen Gesellschaft, vol. 21, no. 13-14, July 30, 1919, pp. 495-500. It is pointed out that the history of the theoretic study of electric phenomena in moving bodies has led physicists more and more to conviction that their reduction to mechanical phenomena is not possible, and writer explains reasons for this impossibility. Reply to above article by Max Jacob, pp. 501-503.

Note on the Central Differential Equation in the Relativity Theory of Gravitation, A. R. Forsyth. Proc. Roy. Soc., vol. 97, no. A682, Apr. 1, 1920, pp. 145-151. Equation is integrated, and approximations for solar system are obtained.

RESEARCH

Metallurgical, Utah School of Mines

The Metallurgical Research Department of the Utah State School of Mines, L. W. Chapman. Chem. & Metallurgical Eng., vol. 22, no. 19, May 12, 1920, pp. 877-881, 5 figs. Station is used for general work in ore dressing, and researches of chloride volatilization and oil shales. Equipment is described.

[See also AERONAUTICS, Research; COLLOIDS, Research; FUELS, Research; RADIOMETALLOGRAPHY, Research.]

RESERVOIRS

Bank Slides

Experiences with Bank Slides in Reservoirs (Einige Erfahrungen über Rutschungserscheinungen bei Stauseen), G. Lüscher. Schweizerische Bauzeitung, vol. 75, no. 12, Mar. 20, 1920, pp. 129-133, 2 figs. Writer refers to reply by Hans Roth to his former article on this subject, both published in previous issues of same journal, in which Roth gives as cause of bank movement when lake level is lowered the reduction of water pressure on the bank, whereas writer's theory is that movement is caused by increase in weight following decrease of buoyancy with repeated recharging and emptying. Writer gives account of experiences and facts to bear out his argument.

RIVERS

Form of Bed

Geometrical Form of Rivers, L. Fargue. Sci. Am. Monthly, vol. 1, no. 5, May 1920, pp. 446-447, 3 figs. Technical notes on design of spur dikes. Translated from Annales des Ponts et Chaussées, 1903 and 1907.

ROAD CONSTRUCTION

Federal Aid

For What Class of Roads and What Type of Construction Should Federal Aid Funds be Used? Thomas H. MacDonald. Good Roads, vol. 19, no. 15, Apr. 14, 1920, pp. 199-200 and 203. Writer expresses opinion that "federal aid funds should be expended, either for the low-cost types in the building of which machinery is used practically altogether, or for the higher-cost roads, for which machinery, if not already developed, is rapidly being developed."

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ENGINEERING INDEX (Continued)

Specifications for Ashokan Highways

Construction and Maintenance of the Ashokan Highways, George G. Honness. Eng. News-Rec., vol. 84, no. 14, April 1, 1920, pp. 652-657, 4 figs. Specifications for mixed bituminous concrete, vitrified brick on concrete foundation, waterbound macadam, and asphalt block roads within area of Ashokan reservoir, located in foothills of Catskill Mountains, which is principal impounding reservoir for New York's Catskill water supply.

Wisconsin

Wisconsin Standardizes Highway Cost Estimates. Eng. News-Rec., vol. 84, no. 14, April 1, 1920, pp. 663-664, 1 fig. Standard bidders' estimating form prepared for use of state highway engineers in estimating cost of improvements and for use of contractors in preparing bidding prices for construction.

[See also ROADS, MACADAM, Surfacing.]

ROADS

Impact Tests on

The Present Status of Impact Tests on Roadway Surfaces, A. T. Goldbeck. Public Roads, U. S. Dept. Agriculture, Bur. Public Roads, vol. 2, no. 18-19, Oct.-Nov. 1919, pp. 19-25, 13 figs. Also Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 265-269, 11 figs. Account of experiments being conducted by Bureau of Public Roads with a view to determining fundamentals affecting road design. Highest value of impact pressure so far measured is 42,000 lb. when weight on rear wheel causing this pressure was only 7750 lb.

ROADS, CONCRETE

Delaware

Concrete Road Construction Methods on Contract No. 8 of the Du Pont Highway, Delaware, George A. Sherron. Eng. & Contracting, vol. 53, no. 14, April 7, 1920, pp. 402-404, 5 figs. Construction of road for distance of six and one-half miles. Road is of 1-course cement concrete, mixed in proportions of 1 part cement, 2 parts fine aggregate and 4 parts coarse aggregate, to which 10 per cent by volume of hydrated lime is added.

Design and Construction

The Design and Construction of Different Types of Pavements, A. N. Johnson. Good Roads, vol. 19, no. 14, April 7, 1920, pp. 182-186, 2 figs. Construction details of concrete roads including method of testing sand for organic impurities, Abram's table of proportions and quantities for one cubic yard of concrete and suggested specifications for proportions using Abram's table.

ROADS, MACADAM

Surfacing with Asphaltic Concrete

Asphaltic Concrete on Old Macadam, W. R. Macatee. Good Roads, vol. 19, no. 15, Apr. 14, 1920, pp. 193-194, 2 figs. Examples of successful use of asphaltic concrete wearing surfaces laid on old macadam roadways as foundations are quoted and construction methods followed are indicated.

Surface Treatment

Surface Treatments on Macadam Roads, Philip P. Sharples. Contract Rec., vol. 34, no. 15, Apr. 14, 1920, pp. 351-353. Describes system which has been worked out in Maine and New Hampshire using cold refined tars that enable these roads to carry 2000 to 3000 automobiles per day through summer season.

ROCK CRUSHING

Plants, Electric Operation of

Use of Electric Drives in Rock-Crushing Plants, Walter D. Myers. Cement, Mill & Quarry, vol. 16, no. 8, April 20, 1920, pp. 25-26. Data on operating costs with electric service as compared with steam power plants.

ROLLING MILLS

Experimental

Design of Experimental Rolling Mill—I, W. B. Skinkle. Blast Furnace & Steel Plant, vol. 8, no. 5, May 1920, pp. 271-273, 4 figs. Details of experimental rolling mill which Carnegie Inst. of Technology is planning to install.

Hot Rolling, Theory of

The Theory of Hot Rolling and the Determination of Work Required (Zur Kenntnis des Arbeitsbedarfes und der Theorie des Warmwalzens), Frithiof F. son Holmgren. Stahl u. Eisen, vol. 40, no. 6, Feb. 5, 1920, pp. 181-188, 6 figs. Determination of work required in rolling by means of a tachograph with constant paper speed. Analysis of Puppe tests and confirmation of certain laws according to which work varies with temperature.

Operation

Rolling Bars in Merchant Sizes, John D. Knox. Iron Trade Rev., vol. 66, no. 16, Apr. 15, 1920, pp. 1123-1127, 6 figs. Operation of 16- and 10-in. rolling mills at works of Hammond Steel Co., Syracuse, N. Y.

Plate Mill

Electrical Equipment in Steel Plate Mill, C. H. Wright. Elec. News, vol. 29, no. 8, April 15, 1920, pp. 34-36, 3 figs. Installation for producing ships' plates at works of Dominion Iron & Steel Co., Sydney.

Sheet Mill, Ohio

Falcon Steel Company Operates Sheet Mill. Modern Plant Uses Powdered Coal Fuel. Blast Furnace & Steel Plant, vol. 8, no. 5, May 1920, pp. 274-280, 12 figs. Sheet mills of Falcon Steel Co., of Niles, Ohio. Features to which attention is directed are extra heavy mills, electric drive, pulverized-coal fuel, continuous pair furnaces, electric charging, water-cooled floors, and steam blast for regulating temperature of hot rolls.

S

SALTS

Precipitation by Refrigeration

Salt Precipitation from Mixed Solutions by Refrigeration. Cold Storage, vol. 23, no. 265, April 15, 1920, p. 93, 2 figs. German apparatus for precipitating salts out of mixed solutions by means of crystallization. This is done by cooling concentrated brines to point where their ability to maintain salts in solution is reduced. Translated from Zeitschrift für die Gesamte Kälte.

SCALES

Tolerances for

Tolerances and Test Loads for Master Scales, E. D. Gordon and C. A. Briggs. Scale Jl., vol. 6, no. 7, April 10, 1920, pp. 25-27, 4 figs. From study of results upon master scale tests made during past four years, Bur. of Standards recommends adoption of tolerance system proportional to square root of corresponding test loads, and that a test of 60,000 lb. be used for purpose of adjusting master scales.

Track

New Track Scale Contains Many Novel Features, L. R. Boyer. Ry. Age, vol. 68, no. 19, May 7, 1920, pp. 1345-1347, 6 figs. Fairbanks model designed to conform to specifications adopted jointly by Am. R. R. Assn., Am. Ry. Eng. Assn., Railroad and Warehouse Commission of Minnesota, Nat. Scale Manufacturers' Assn., Bur. of Standards, and Scale Manufacturers' Assn. Design includes use of levers of double web section to which loads are transmitted through center lines.

Specifications for Railroad Track Scales. Bul. Am. Ry. Eng. Assn., vol. 21, no. 225, March 1920, pp. 5-101, 24 figs. Rules for location, maintenance, operation and testing of scales are suggested. Specifications apply to knife edge scales of straight and torsion lever types for weighing cars in regular interchange service. They were prepared by committee representing Am. Railroad Assn., Am. Ry. Eng. Assn., U. S. Bur. Standards, Railroad & Warehouse Commission of Minnesota, Nat. Scale Men's Assn. & Scale Manufacturers' Assn.

SCANDIUM

Separation of

Contribution to the Study of Scandium (Contribution à l'étude du scandium), Jean Sterba-Boehm. Bulletin de la Société Chimique de France, vol. 27-28, no. 4, Feb. 20, 1920, pp. 185-195. Methods for separating scandium from ytterbium, thorium and other rare earths with which it occurs in wolfram.

SCHOONERS

Auxiliary, Diesel-Engined

Diesel-Engined Auxiliary Schooners, C. E. Spinnler. Int. Mar. Eng., vol. 25, no. 5, May 1920, pp. 402-405, 9 figs.; partly and 2 supp. plates. Details of machinery installed in Italian sailing vessel for auxiliary power. Vessel is 236 ft. long.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SEARCHLIGHTS

Military

Military Searchlights, S. G. Hibben. Proc. Engrs. Western Pennsylvania, vol. 36, no. 2, Mar. 1920, pp. 81-101 and (discussion) pp. 102-108, 13 figs. Researches which led to designs used by Am. Expeditionary Forces.

SEWAGE TREATMENT

Activated Sludge

Activated-Sludge Experiments at Worcester, Massachusetts, Ray S. Lamphear. Eng. News-Rec., vol. 84, no. 17, April 22, 1920, pp. 819-823, 2 figs. Year's study of new process is said to have shown it not to be so well adapted to Worcester sewage as Imhoff tanks and sprinkling filters.

Canada's First Successful Activated Sludge Sewage System at Brampton, Ont., G. Graham Reid. Contract Rec., vol. 34, no. 13, Mar. 31, 1920, pp. 292-297, 7 figs. Description of plant in which old septic tank was rearranged as aeration chamber. Plant, it is said, has operated excellently for several months.

SEWER DESIGN

Backwater Curves

Computation of Backwater Curves in Sewer Design, C. D. Hill. Mun. & County Eng., vol. 58, no. 4, April 1920, pp. 164-167, 2 figs. Curves show hydraulic elements for circular and horseshoe sewers for uniform discharge and varying depths.

SEWER PIPE

Specifications

Los Angeles Sewer Pipe Specifications. Public Works, vol. 48, no. 17, May 8, 1920, pp. 404-405. Recently adopted specifications give requirements for clay and cement pipe identical in most respects. Sand-bearing pressure, hydrostatic and absorption tests are made of both. Sewer joint compounds are provided for, and test for tightness of completed sewer.

SEWERS

Concrete, Specifications for

Concrete Sewer Standard Specifications. Public Works, vol. 48, nos. 14 and 15, Apr. 17 and 24, 1920, pp. 335-337 and 355-356. Report of Committee on Concrete Sewers of Am. Concrete Inst., containing tentative standard specifications for construction of concrete pipe, arch and slab sewers. Requirements proposed for adoption as standard include features commonly used in advanced structure practice and give special attention to invert construction, arch forms, backfilling, etc.

SHIP DESIGN

Keel, Shape of

Keel Shape of Least Resistance to Translation in Free Air at All Speeds (Formes de carènes de moindre résistance a leur translation à l'air libre, à toutes les vitesses), F. E. Fournier. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 10, Mar. 8, 1920, pp. 547-552. It is investigated by mathematical reasoning that shape of least resistance is tetrahedron having for "flotation plane," and for "flat bottom" inclined to this plane by 5 deg. 18 min. 30 sec., two isosceles triangles adjacent at the base, of the same breadth at the stern, and connected at their vertices to the two extremities of the vertical cutwater of the keel.

Rest Moment

The "Rest Moment" in Connection with Calculations of Longitudinal Strength (Das "Restmoment" bei Längsfestigkeitsrechnungen), H. Schultz. Schiffbau, vol. 21, no. 12, Feb. 11, 1920, pp. 391-396, 10 figs. It is pointed out that in computing strength for ships in wave crest and wave trough, if centers of buoyancy and of gravity do not lie in same vertical, a rest moment occurs which, it is claimed, can prove troublesome to conscientious calculators. Method is explained, by means of which it is said to be possible to calculate longitudinal strength without predetermination of center of gravity, whereby rest moment is equalized by correction curves.

SHIPS

Twin-Screw, Passenger Steamer

Twin-Screw Coastwise Passenger Steamer. Int. Mar. Eng., vol. 25, no. 5, May, 1920, pp. 396-398, 7 figs. Ship designed for service on coast route between Vancouver and Prince Rupert. Specifications: Length overall, 251 ft. 6 in.; beam molded, 37 ft. 3 in.; depth molded, 16 ft.; displacement, 2,000 tons; indicated horsepower, 2,800; speed, 16 knots.

SHIPS, CONCRETE

Design

Add Interior Braces and Stirrups to Concrete Tankers. Eng. News-Rec., vol. 84, no. 15, April 8, 1920, pp. 705-708, 5 figs. Structural weaknesses discovered led to changes in framing of 7,500-ton concrete oil tankers under construction by U. S. Shipping Board. Corrections consist in adding more shear steel in outer main frames and placing additional interior bracing in order to make possible docking of ships on center keelson.

SHIPYARDS

Australia

The Largest Shipyard in Australia, John O'Toole. Int. Mar. Eng., vol. 25, no. 5, May 1920, pp. 444-448, 9 figs. Equipment consists of three large building ways, each 360 ft. in length and 60 ft. wide, constructed on concrete

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ENGINEERING INDEX (Continued)

foundations, and one smaller building slip and two patent slips for docking vessels up to 600 tons.

SILVER MINING

See GOLD MINING, Electrical Equipment for.

SNOW PLOWS

Friedman Snow Tank

New Type of Plow Cleans Snow from Streets at Low Cost. Contract Rec., vol. 34, no. 15, Apr. 14, 1920, pp. 340-341, 2 figs. Friedman snow tank, which, it is claimed, has been tried out in New York with splendid results. It is stated that four 5-ton trucks were filled with ice in less than 3 min., and saving of $5.48 per 8 cu. yd. over hand methods is effected.

SPARK PLUGS

Specifications

Motor Transport Corps Spark-Plug Specifications. Jl. Soc. Automotive Engrs., vol. 6, no. 5, May 1920, p. 281. Specifications for spark plugs to be purchased for Motor Transport Corps to be used on military equipment. Methods of testing for dielectric strength and thermal cracking and gas-tightness are specified.

SPRING MOTORS

Krasco

Manufacturing Krasco Spring Motors, Edward K. Hammond. Machy. (N. Y.), vol. 26, nos. 8 and 9, Apr. and May 1920, pp. 737-741 and 863-868, 23 figs. Description of the "Krasco" phonograph motor and organization and arrangement of the Krasberg Eng. & Mfg. Corporation's plant.

STANDARDIZATION

Necessity for

Standards, H. K. Hathaway. Bul. Taylor Soc., vol. 5, no. 1, Feb. 1920, pp. 12-39 and (discussion) pp. 39-42, 22 figs. Necessity for introducing standards of tools, machines, records, and methods is pointed out and instances are quoted of work in various plants operated according to Taylor system, in which by special research and analysis principles were formulated in order to determine standards for various mechanical appliances.

Trade Association Work in

Engineering in Trade Association Work, Wharton Clay. Jl. Western Soc. Engrs., vol. 25, no. 6, March 20, 1920, pp. 181-220. It is pointed out how trade associations may undertake engineering standardization in industries. Reference is made to difficulties experienced during the war by United States Government in dealing with industries in consequence of lack of standardization in manufacture of products. Trade associations, it is believed, can remedy this situation and thereby prepare the country for speedier mobilization of industry in case of war.

STEAM ENGINES

Clausius-Rankine Cycle

The Thermodynamic Cyclic Process for Investigation of Steam Engines (Die thermodyamischen Kreisprozesse zur Beurteilung von Kraftmaschinen), R. Plank. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 10, Mar. 6, 1920, pp. 221-227, 5 figs. Writer seeks to convince members of Assn. of German Engrs. that the thermodynamic cyclic process for a steam engine accepted by the Assn. as standard, and according to which no account is taken of total expansion, should be discarded and replaced by the Clausius-Rankine cycle, for which formulæ are presented.

STEAM POWER PLANTS

England

New Plant for the Grove Road Power Station. Elec. Times, vol. 57, no. 1486, April 8, 1920, pp. 297-299, 7 figs. Installation of two 10,000-kw. turbo-alternators at Grove Road works of Central Electric Supply Co., Ltd.

Western States, Tendencies in Design

Steam-Electric Generation in Far West, W. F. Durand and C. H. Delany. Elec. World, vol. 75, no. 20, May 15, 1920, pp. 1123-1127, 10 figs. Survey of present tendency of design. Leaning is said to be toward higher superheat, centrifugal-pump auxiliaries, automatic control and use of recording meters in boiler room.

STEAM TURBINES

Tandem Compound

New Unit in Fisk Street Station, F. A. Hatch. Power Plant Eng., vol. 24, no. 10, May 15, 1920, pp. 507-509, 3 figs. Twenty-five cycle, 35,000-kw. tandem-compound steam-turbine unit recently put into operation at Fisk Street Station of Commonwealth Edison Co., Chicago.

[See also COAL MINES, Exhaust-Steam Utilization.]

STEEL

Absorption Power, Testing

Testing the Absorption Power of Different Steels Under the X-Rays, Robert Hadfield, S. A. Main, J. Brooksbank. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 74-75, 4 figs. on 2 supp. plates. Account of experiments carried out by Hadfield Research Laboratory in Sheffield, England. Best results were found by intensifying negatives of radiographs. Order of density on radiograph prints after intensification is said to be the same as order of specific gravity.

Cold-Rolled Strip

Cold Rolled Strip Manufacture and Products. Raw Material, vol. 2, no. 4, April 1920, pp. 131, 140, 19 figs. Description of strip steel manufactured into finished products.

Cold Working of

Results of Cold Working in the Manufacture of Hydrogen Bottles (Folgen der Kaltbearbeitung von Wasserstofflaschen), Ernst Bock. Stahl u. Eisen, vol. 39, no. 48, Nov. 27, 1919, pp. 1467-1470, 6 figs. In 1918 a bottle containing hydrogen exploded at the Schwarzenberg Hydrogen and Oxygen Works in Saxony, causing the destruction of welding room and loss of 17 lives. Results of investigation of broken pieces are said to prove that tensile strength was sufficient, but high degree of brittleness was shown, which, it is claimed, was result of the cold-drawing of material in bottle.

Elastic Strengths

The Relation Between the Elastic Strengths of Steel in Tension, Compression and Shear, Fred B. Seely and William J. Putnam. University of Illinois Bul., vol. 17, no. 11, Nov. 10, 1919, 49 pp., 9 figs. Results of experiments with soft, mild and medium carbon steel, and vanadium, nickel and chrome-nickel alloy steel. It is concluded in part that correct value of elastic shearing strength of steel as measured by proportional limit or useful limit point is from 0.55 to 0.65 of elastic tensile strength, thus disproving maximum shear theory of failure of elastic action of tensile steel, sometimes called Guest's law, which assumes that elastic shearing strength is 0.5 of elastic tensile strength.

Exportation

Exporting Iron and Steel—I and II, V. G. Iden. Iron Trade Rev., vol. 66, nos. 14 and 18, April 1 and April 29, 1920, pp. 987-991 and pp. 1257-1261. World market conditions and problems in foreign trade analyzed. Influence of tariff and quantity production by American industries on foreign trade. Export combinations encouraged.

Ferrite in

Genesis of Ferrite, Federico Giolitti. Chem. & Metallurgical Eng., vol. 22, no. 16, Apr. 21, 1920, pp. 737-739, 10 figs. Writer claims that, contrary to commonly accepted ideas, ferrite in hypo-eutectoid steels is not extruded as a shell to outside of austenitic kernels, but exists as an aggregation of crystals essentially discontinuous and originating at low-carbon nuclei of solid solution grains.

Market Conditions, Factors Affecting

World's Steel Output Below Need, John A. Topping. Iron Trade Rev., vol. 66, no. 19, May 6, 1920, pp. 1321-1322. Underlying factors which offset market and price conditions are pointed out. It is stated that European production is scarcely one-third of pre-war figure. Heavy railroad and agricultural demands are forecast.

Microstructure of

Microstructure of Iron and Mild Steel at High Temperatures, Henry S. Rawdon. Min. & Metallurgy, No. 158, Section 18, Feb. 1920, 20 pp., 13 figs. Experimental investigation of surface layer during heating in vacuo, and of formation of surface pattern under "heat-relief" etching.

Properties Below Critical Range

Physical Changes in Iron and Steel Below the Thermal Critical Range, Zay Jeffries. Min. & Metallurgy, No. 158, Section 20, Feb. 1920, 17 pp. Survey of technical literature and account of experimentation work. Committee report presented to Engineering Division of Nat. Research Council.

Sulphur in

Studies Sulphur Problem Abroad, Henry S. Rawdon. Iron Trade Rev., vol. 66, no. 15, Apr. 8, 1920, pp. 1069-1071. Representative of United States Bureau of Standards reports that French and British specifications for steels furnish few data applicable to research on effect of sulphur and phosphorus.

Testing

Comparative Static and Dynamic Tensile Tests (Vergleichende statische und dynamische Zugversuche), Otto Fuchs. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 12, Mar. 20, 1920, pp. 273-277, 5 figs. Results of comparisons are said to show that capacity for deformation under dynamic stress is greater for soft iron and less for steel than under static stress; the tension-elongation curve increases under dynamic stress less rapidly than under static stress.

STEEL CASTINGS

Failure of

Using the Microscope to Detect Causes of Failure of Steel Castings, O. A. Knight. Blast Furnace & Steel Plant, vol. 8, no. 5, May 1920, pp. 281-283, 9 figs. It is pointed out how microscope can determine correct heat treatment to give to steel castings. Photomicrographs are presented and interpreted.

Heat Treatment of

Investigations of the Influence of Heat Treatment on the Quality of Steel Castings (Untersuchungen über den Einfluss der Wärmebehandlung auf die Qualität des Stahlgusses), Erdmann Kothny. Giesserei-Zeitung, vol. 16, nos. 23 and 24, Dec. 1 and Dec. 15, 1919, pp. 357-361, 10 figs., and pp. 374-379, 11 figs. Results of investigations of influence of annealing and of refining on strength of soft electric steel castings are said to show that the Heyn bending test and the State Railroad tests are of no value for the determination of quality of annealed or refined soft steel castings.

Microscopic Examination of

Using the Microscope to Detect Causes of Failure of Steel Castings, O. A. Knight. Am. Drop Forger, vol. 6, no. 4, April 1920, pp. 163-165, 9 figs. Photomicrographs of various specimens are studied and it is pointed out how defects in heat treatment can be determined by means of them.

STEEL, HEAT TREATMENT OF

Furnaces

Furnaces Used in Heat-Treating Steel, S. P. Rockwell. Machy. (N. Y.), vol. 26, no. 8, Apr. 1920, pp. 749-753, 6 figs. Comparison of types of furnaces used in carburizing, hardening and tempering.

Regulation of

Important Factors to be Considered in Heating and Cooling Steel, C. B. Barnhardt. Am. Drop Forger, vol. 6, no. 4, April 1920, pp. 189-193, 4 figs. Uniform pyrometer record is said not to be sufficient indication of proper heating or cooling. It is pointed out that temperature, time, surface and mass are the factors which must be considered in heat-treating.

[See also STEEL CASTINGS, Heat Treatment; STEEL, NICKEL, Thermal Treatment.]

STEEL, HIGH-SPEED

Electric-Furnace Manufacture

The Manufacture of High Speed Steel in the Electric Furnace, Roy C. McKenna. Gen. Meeting Am. Electrochemical Soc., Apr. 8-10, 1920, paper no. 31, pp. 417-423. Advantages of electric furnace process over any other way of making high-speed tool steel are pointed out and details of charging, melting, slagging, teeming, forging, heat treatment, etc., are discussed.

Tests

A Comparative Test Upon High-Speed Steels—I and II, A. J. Langhammer. Chem. & Metallurgical Eng., vol. 22, nos. 18 and 19, May 5 and May 12, 1920, pp. 829-833 and pp. 889-892. Notes on competition of modern high-speed steels conducted for automotive manufacturer. Preliminary observations on current sales practices and general review of various classes, and effect of chemical compositions and heat treatment. Conditions entering into testing of tool for cutting, listed by Taylor, are discussed. Detailed information is given as to method of eliminating most of variables from comparative test for efficiency of several brands of commercial tool steel.

STEEL INDUSTRY

Germany

German Steel and Iron in 1920—I, II, III and IV, H. Cole Estep. Iron Trade Rev., vol. 66, nos. 15, 16, 17, 18, April 8, 15, 22, 29, 1920, pp. 1059-1063, 2 figs., pp. 1131-1139, 6 figs., pp. 1189-1193, 4 figs., pp. 1263-1267, 7 figs. Based on writer's personal investigations. Iron and steel industry, it is said, is displaying a certain amount of spirit, energy and valor in its present struggle, but it will be long, if at all, before it can recuperate its former position. Official statistics are quoted which show production has reduced two-thirds since 1913. Labor conditions as affected by food situation. With steel production at low ebb Germany is said to have excess of shop capacity and her shipyards to be nearly idle.

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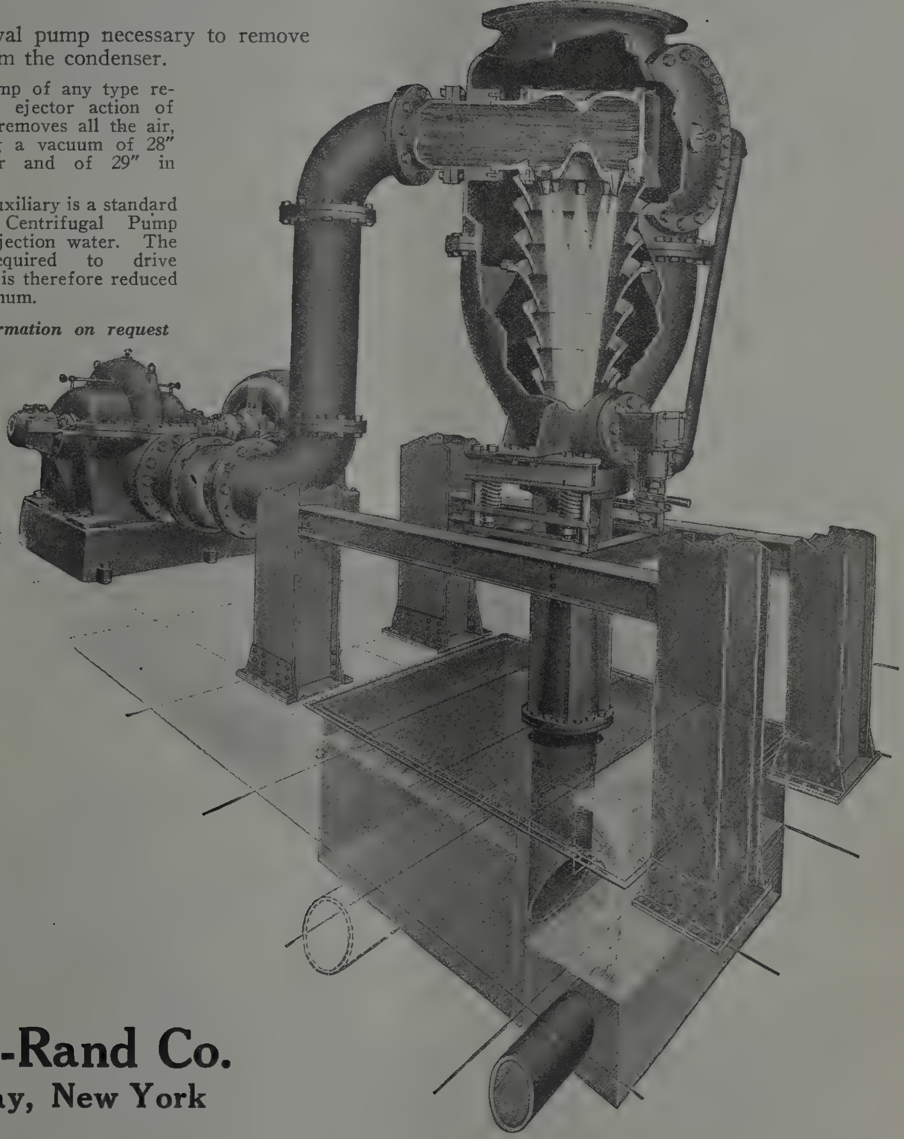

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STEEL, MANGANESE

Grinding

Grinding Manganese Steel, R. M. Johnson. Iron Trade Rev., vol. 66, no. 14, Apr. 1, 1920, pp. 999-1001, 10 figs. Methods employing swing frame grinding machines are illustrated.

STEEL MANUFACTURE

Bessemer Process

Metallurgical Procedures for Acid and Basic Bessemer Processes Based on Spectrum-Analysis Observations (Die metallurgischen Vorgänge beim sauren und basischen Windfrischverfahren auf Grund spektralanalytischer Beobachtungen), L. C. Glaser. Stahl u. Eisen, vol. 40, no. 6, Feb. 5, 1920, pp. 188-193, 11 figs. It is claimed that by application of spectrum-analysis observations in connection with customary tests, it is possible to control Bessemer process and also to determine the melting action and, accordingly, to measure and regulate the addition of alloy. Bibliography containing 72 references is included. (Concluded.)

Duplexing Process

Develops New Duplexing Process, H. E. Diller. Iron Trade Rev., vol. 66, no. 19, May 6, 1920, pp. 1324-1327, 9 figs. High-carbon steel is melted in electric furnace and transferred to converter to be finished. It is said that good grade metal is thus obtained at low cost.

Electric-Furnace

Manufacture of Steel in the Electric Furnace **(Le four à arc pour la fabrication de l'acier)**, H. Verdinne. Revue universelle des Mines, vol. 5, no. 1, Apr. 1, 1920, pp. 5-52, 26 figs. Classification and description of principal types of electric furnaces used in steel manufacture. (To be continued.)

Electric Heating in

Electric Heating in Steel Wire Manufacture. Blast Furnace & Steel Plant, vol. 8, no. 5, May 1920, pp. 291-293, 2 figs. Comparative cost statistics taken at plant of Halcomb Steel Co., Syracuse, N. Y., on drying ovens heated electrically and similar ovens using coke and steam. Coke ovens cost $22.289 per net ton, against $12.2926 per net ton for electric.

[See also ELECTRIC FURNACES, Metallurgical Uses.]

STEEL, NICKEL

Thermal Treatment

Critical Ranges of Some Commercial Nickel Steels, Howard Scott. Min. & Metallurgy, No. 158, Section 16, Feb. 1920, 17 pp., 11 figs. Transformation-temperature data secured at Bureau of Standards as basis for standardization and specification of thermal treatments for nickel steels.

STEEL WORKS

Electricity in

Electricity in a Large Modern Steel Plant—I, R. B. Gerhardt. Blast Furnace & Steel Plant, vol. 8, no. 5, May 1920, pp. 295-298. Details of electrical apparatus at Maryland plant of Bethlehem Steel Co. Paper read before Philadelphia Section of Assn. of Iron & Steel Elec. Engrs.

Electricity Plays Important Part in Connecticut Steel Foundry. Iron Trade Rev., vol. 66, no. 12, Mar. 18, 1920, pp. 846-849, 5 figs. Electricity is used for melting charge, baking, cores, annealing and heat-treating castings, and in cleaning room.

STORAGE BATTERIES

Improvements in

Progress in Accumulator and Element Technique (Neuerungen auf dem Gebiete der Akkumulatoren- and Elementetechnik), A. Blaschke. Elektrochemische Zeitschrift, vol. 26, no. 8-9, Nov.-Dec. 1919, pp. 87-91. Improvements of accumulator paste by rendering it more porous by chemical or mechanical means or by both combined are noted and various patents for manufacture of accumlators, electrodes and accumulator plates are described.

STOKERS

Conveyor-Feed Type

A Stoker for Burning Eastern Coals, L. R. Stowe. Mech. Eng., vol. 42, no. 5, May 1920, pp. 279-282, 4 figs. Stoker developed by Laclede-Christy Clay Products Co. It is of conveyor-feed type and operates with mechanical draft. Caking is said to be prevented by high ignition temperatures employed, graduation of supply from feeding and to discharge end, and thickening of fire at point of ash discharge.

Performance

Exact Data on the Performance of Mechanical Stokers as Applied to "Lancashire" or Other Narrow-Flued Boilers, David Brownlie. Jl. Instn. Mech. Engrs., no. 3, Apr. 1920, pp. 263-280. Figures obtained in experimental investigation of 80 typical Lancashire boilers mechanically fired. (To be continued.)

STREET RAILWAYS

Car Maintenance

Maintenance Practice of the Anglo-Argentine Tramway—II, R. Francisco Apeseche. Elec. Ry. Jl., vol. 55, no. 20, May 15, 1920, pp. 978-982, 7 figs. Classes for inspection and overhauling of cars are described, together with duties of men and types of work performed.

Cars, Converting

Open Trailers Converted into Desirable Closed Cars. Elec. Traction, vol. 16, no. 5, May 1920, pp. 331-332, 3 figs. Old-type open trailers in Memphis converted into closed cars at a cost of about $1500.

Cars, Non-Electric

Is the Non-Electric Street Railway Car a Serious Possibility? Ferdinand C. Cusani. Elec. Ry. Jl., vol. 55, no. 18, May 1, 1920, pp. 893-895. Writer believes that there is a field for self-propelled safety car, but considers steam power plant to be superior to oil or gas engine for purpose.

Cars, Safety

A New Saftey Car Produced en Masse. Elec. Ry. Jl., vol. 55, no. 20, May 15, 1920, pp. 983-986, 4 figs. Osgood-Bradley safety car. It is of standardized design, but strength has been increased and 6-in. crown has been added to vestibule to secure handsomer outlines.

Cars vs. Omnibuses

Street Passenger Transport of London, William Worby Beaumont. Jl. Roy. Soc. Arts, vol. 68, no. 3518, Apr. 23, 1920, pp. 368-375 and (discussion) pp. 275-380. Discussing problem of increasing transportation facilities of London, author states, from survey of records of operation of tramways and omnibuses, that greater convenience of latter, and their proved rapidity of loading and celerity of dispatch, makes it desirable to consider the total removal of tramways and operation of all surface passenger traffic with omnibuses.

Current Losses

Current Losses Which Take Place Along the Track of a Street Railway (Note sur les pertes de courant qui se produisent le long d'une voie de tramways), G. Girousse. Revue générale de l'Électricité, vol. 7, nos. 12 and 13, March 20 and March 27, 1920, pp. 404-409, 6 figs., and pp. 423-430, 14 figs. Approximate theory is existing between rails and soil. Theory is aprents formed by reason of potential difference developed for estimating intensities of idle curplied to a number of particular cases. Graphs are included, which indicate, in each case, electric state of tract according to position of car.

Operation

Making the Best Use of the Car Equipment, E. H. Scofield. Elec. Ry. Jl., vol. 55, no. 19, May 8, 1920, pp. 942-946, 10 figs. Method is suggested for studying car operation by means of curves showing effects of varying several component parts of schedule, such as, for example, length of run, accelerating rate, braking rate, standing time and traffic interference.

Track Construction

Street Railway Permanent Track Construction, C. C. Sutherland. Can. Engr., vol. 38, no. 17, April 22, 1920, pp. 393-400, 13 figs. Discussion of factors determining design of rails, rail joints, bonding, track drainage, base and paving. Reference is made to practice followed at Edmonton, Alberta, Canada.

STREET RAILWAYS, TRACK

Curves

Relation Between Wheel and Rail in Street Railways (Contribution à l'etude des relations entre les véhicules et les voies dans les tramways). Industrie des Tramways et Chemins de Fer, vol. 13, no. 154-155-156, Oct.-Nov.-Dec. 1919, pp. 146-153, 14 figs. Question whether gage should be widened or narrowed in curves of street railway track is discussed. It is found that shape of wheel flanges should determine practice to follow in any case. Equation expressing track gage in terms of characteristics of flanges, radius of curvature, etc., is derived and interpreted.

STRESSES

Direct Determination

Plane Strain: the Direct Determination of Stress, S. D. Carothers. Proc. Roy. Soc., vol. 97, no. A 682, Apr. 1, 1920, pp. 110-123, 5 figs. Stress equations of equilibrium of elastic solid are given in rectangular, plane polar, and orthogonal curvilinear coördinates, together with identical relations between strain components in each case.

STUDS

Tap-End Sizes

Tap-End Sizes of Studs. Am. Mach., vol. 52, no. 15, April 8, 1920, pp. 773-775. Question whether tap end should be tight on thread or depend on being jammed on last thread is discussed. Practice of two large companies making studs for the market is given.

SUBWAYS

Cleveland

Rapid Transit for Cleveland, Henry M. Brinckerhoff. Elec. Ry. Jl., vol. 55, no. 17, April 24, 1920, pp. 856-858, 2 figs. Outline of project involving construction of subway.

London, Rolling Stock

New Rolling Stock for Bakerloo and Watford Service. Tramway & Ry. World, vol. 47, no. 19, Apr. 15, 1920, pp. 185-188, 8 figs. Cars of London and North-Western and London Electric Railway companies. Dimensions of passenger cars for tubes are: Length overall, 50 ft. 10 in.; width over body, 8 ft. 8 in.; total height from rail, 9 ft. 5¼ in.; diameter of motor wheels, 42 in.; diameter of trailing wheels, 32 in.; weight of 6-car train loaded, 161 tons, 2 cwt.

Madrid

The Underground Railway of Madrid (Le métropolitain "Alphonse-XIII" de Madrid), J. Eugenio Ribera. Génie Civil, vol. 76, no. 10, Mar. 6, 1920, pp. 251-254, 9 figs. Total length of line is 3839 meters. Stations are placed at average distance of 500 m. Maximum grade is 40 mm. per m. and minimum radius 90 m.

SUPERHEATERS

Economy Obtained with

Superheaters and the Utilization of Superheated Steam, D. D. Pendleton and C. A. Brandt. Proc. Engrs. Soc. Western Pennsylvania, vol. 36, no. 1, Feb. 1920, pp. 25-53, and (discussion) pp. 53-79. Economy obtained with superheaters is pointed out together with increase of boiler efficiency resulting from their use, and reference is made particularly to importance of using superheaters in steam turbines. Various types of superheaters are described and requisites of ideal superheater are worked out.

Manufacture

The Fabrication of the Return-Bend Portions of U-Shaped Superheater Tubes (Die Herstellung der Umkehrstücke U-förmiger Ueberhitzerröhre), H. Theobald. Metall, vol. 1919, nos. 20 and 21, Oct. 25 and Nov. 10, 1919, pp. 271-274 and 288-290, 51 figs. Notes on method for producing hood from two parallel tubes with connecting bar; producing double hood by joining two tubes; forming hood and tube connecting branches from flat tubing; forming reversing part from a whole working piece, and various other processes. (Concluded.)

SURVEYING

See AEROPLANES, Surveying and Mapping.

SWAGING MACHINES

Langelier

The Langelier Hot Swaging Machine, E. L. Dunn. Am. Mach., vol. 52, no. 15, April 8, 1920, pp. 790-791, 6 figs. Two oppositely disposed swaging dies are carried in spindle head and are caused to open and close rapidly as spindle revolves. Dies deliver 900 blows per minute, and the work is thus swaged into shape as it is fed into dies.

SWITCHBOARDS

Shipyard Installation

The Central Switchboard Installation of the Vulkan Shipyard and Machine Factory at Bremen (Die Gesamtschaltanlage des Bremer Vulkan, Vegesack), A. Lütjen. Schiffbau, vol. 21, no. 4, Nov. 26, 1919, pp. 128-157, 6 figs. Details of switchboard installation in shipyard with 1500 m. water front, and employing about 4,000 men. Discusses voltage used, safety features incorporated, etc.

T

TANKS, MILITARY

Track Links, Manufacture of

The Manufacture of Track Links for Tanks, H. Varley. Eng. & Indus. Management, vol. 3, no. 16, April 15, 1920, pp. 486-489, 10 figs. Methods by which track links were manufactured on line of continuous production.

TAYLOR SYSTEM

Advantages and Disadvantages

What Does Taylor Teach Us? (Was lehrt uns Taylor?), M. Reishaus. Deutsche optische

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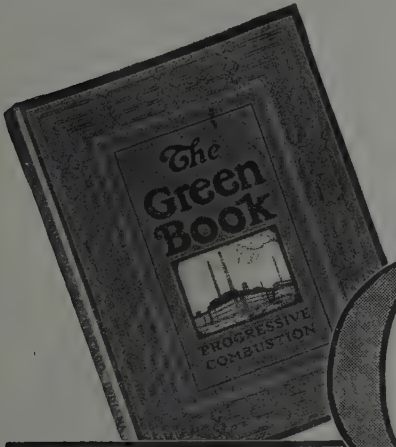

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GREEN CHAIN GRATE STOKERS

Wochenschrift, no. 51-52, Dec. 22, 1919, pp. 364-367. Writer discusses advantages and disadvantages of the Taylor system and points out that danger lies less in the teachings themselves than in the false or indiscriminate application of them to every plant.

TELEPHONY

Automatic

Machine Switching for Automatic Telephony. Elec. Rev. (Chicago), vol. 76, no. 17, April 24, 1920, pp. 687-690, 7 figs. Equipment developed by Bell telephone engineers for automatic handling of calls.

Machine Switching

Machine Switching for Bell System, Bancroft Gherardi. Telephony, vol. 78, no. 18, May 1, 1920, pp. 15-21, 16 figs. System which is to be installed by Bell Companies in larger cities.

Relay Automatic System

The Relay Automatic Telephone System, A. B. Eason. Post Office Elec. Engrs. Jl., vol. 13, part 1, April 1920, pp. 13-21, 6 figs. Description of operation.

TERMINALS, LOCOMOTIVE

Michigan Central R.R.

West Division Engine Terminal, M. C. R. R. Ry. Rev., vol. 66, no. 18, May 1, 1920, pp. 709-717, 22 figs. Terminal consists of 30-stall roundhouse and 6-stall erecting shop with adjacent machine, forge and flue shops, which are all maintained as a unit. Power is supplied from central powerhouse.

TERMINALS, MARINE

Portland, Ore.

St. Johns Municipal Terminal at Portland, Ore. Ry. Rev., vol. 66, no. 19, May 8, 1920, pp. 751-754, 5 figs. Construction of grain elevator with capacity of 1,000,000 bu. and other shipping facilities for handling grain in bulk.

Tractors and Trailers in

Trucks, Tractors and Trailers in Marine Handling, H. C. Yost. Freight Handling & Terminal Eng., vol. 6, no. 4, April 1920, pp. 146-150, 5 figs. Various types are illustrated and estimates of cost of operating them are made.

[See also ARMY SUPPLY BASES.]

TERMINALS, RAILWAY

Relation to City Plan

Relation of Railroad Terminals to City Plan. Ry. Age, vol. 68, no. 18, April 30, 1920, pp. 1285-1288, 2 figs. Report presented to Railroad Committee of Twelfth National Conference on City Planning. Sketch is presented suggesting connection between terminals comparatively remote.

TESTING MACHINES

Impact

New Testing Machines. Iron & Coal Trades Rev., vol. 100, no. 2720, April 16, 1920, p. 526, 4 figs. Description of Eden-Foster repeated impact testing machine and Humfrey autographic notched-bar testing machine.

THERMIONIC VALVES

Low-Power Lamp

A New Low-Power Lamp Rectifier of Alternating Current, John Scott-Taggart. Elecn., vol. 84, no. 2188, Apr. 23, 1920, p. 451, 1 fig. Lamp operates on principle of Edison effect. A flat nickel plate is placed between the two legs of a horseshoe filament of spiralized tungsten wire. External connections are taken from middle point of filament and from plate.

THERMODYNAMICS

See STEAM ENGINES, Clausius-Rankine Cycle.

TIME STUDY

Training of Time Analyst

Time and Job Analysis in Management—II, William O. Lichtner. Indus. Management, vol. 59, no. 5, May 1920, pp. 361-366, 2 figs. Course for training time and job analyst is outlined. Time-study boards and sheets are illustrated and a series of six exercises to be given by an instructor are presented in detail. These are followed by procedure in field work, designated elementary units, recording, and office work.

TIN

Recovery from Mill Dross

Reclaiming Tin Mill By-Products, John D. Knox. Iron Trade Rev., vol. 66, no. 8, Feb. 19, 1920, pp. 551-557, 10 figs. Tin-plate mill of Liberty Steel Co. at Warren, Ohio, is said to recover considerable metal from tin dross by heating and large percentage of middlings by screening.

TIN ALLOYS

Tin-Phosphorus

Tin-Phosphorus Alloys, A. C. Vivian. Metal Industry (Lond.), vol. 16, no. 15, April 9, 1920, pp. 287-292, 5 figs. Account of experiments undertaken to interpret phenomena due to existence of conjugate solutions between certain percentages of phosphorus. Paper read before Institute of Metals.

TOLUOL

Production at Gas Plants

The Production of Toluol From Gas Plants, Myron S. Falk. Proc. Am. Soc. Civil Engrs., vol. 45, nos. 8-9-10, Oct.-Nov.-Dec., 1919, pp. 775-793. How production of toluol, which forms base of T.N.T., was increased in United States from 700,000 gal. in 1914 to rate of 32,000,000 gal. per year in 1919.

TRACTOR ENGINES

Fordson

Pistons for the Fordson Tractor, Fred H. Colvin. Am. Mach., vol. 52, no. 13, Mar. 25, 1920, pp. 675-679, 13 figs. Operations on Fordson piston are outlined and methods of holding piston during different operations are explained.

TRACTORS

Farm

Studies of the Control and Seating Arrangements of Tractors, P. M. Heldt. Automotive Industries, vol. 42, no. 19, May 6, 1920, pp. 1051-1055, 15 figs. Tractor seats and control of American tractor are illustrated. Tendency to adhere to cast-steel seat said to be due to fact that tractors are left in the open and are therefore subjected to all weather conditions.

Steering System

An Analysis of Creeper Type Tractor Steering, E. F. Norelius. Automotive Industries, vol. 42, no. 18, April 29, 1920, pp. 1005-1008, 7 figs. Mechanical study of force and stresses developed in tractor while steering. Proper kind of steering device, it is concluded, is one which has control of gear ratio between one track and the other, so as to force machine to turn, and one which has free mechanical or electrical drive from one side to the other so that the negative pull on inside track will help outside track.

Uses of

Increasing the Utility of the Tractor, Arnold P. Yerkes. Jl. Soc. Automotive Engrs., vol. 6, no. 4, April 1920, pp. 226-230. Efforts of manufacturers to secure adaptability of tractors to other uses than plowing are related and it is pointed out that reason why sales of tractors have not been as extensive as manufacturers had anticipated is because of financial inability of farmers in small farms to invest in a machine from which they cannot derive service in proportion to their investment.

Use of Heavy Tractors for Hauling Elevating Graders and Wagon Trains from Steam Shovel. Eng. & Contracting, vol. 53, no. 16, April 21, 1920, pp. 451-454, 3 figs. Account of work done with three artillery-type tractors designed by War Department for military use, which were employed by U. S. Reclamation Service in construction of Salmon Lake Dam and Conconully dam enlargement of Okanogan Project, Wash.

W.-S.-M.

New Tractor of Frameless Type Has Unit Construction. Automotive Industries, vol. 42, no. 17, April 22, 1920, pp. 948-950, 6 figs. Wellman-Seaver-Morgan Co., tractor, of frameless or backbone type, has three-speed change gear, first reduction by worm and wheel gear, and is short for size of engine carried, wheelbase being only 75 in. Engine is of four-cylinder block type, 4¾x6 in.

TRANSFORMERS

Steel-Clad

Steel Clad Distribution Transformers, E. G. Reed. Elec. Jl., vol. 17, no. 5, May 1920, pp. 213-218, 22 figs. Process of manufacture at works of Westinghouse Elec. & Mfg. Co.

TRESTLES

See BRIDGES, RAILWAY, Wooden.

TRIODE VALVES

Kallirontron

The Kallirontron, an Aperiodic Negative-Resistance Triode Combination, L. B. Turner. Radio Rev., vol. 1, no. 7, April 1920, pp. 317-329, 8 figs. Device consists of combination of circuits, which may be aperiodic, including two ordinary triodes in which secondary emission plays no part, whereby electrical resistance is annihilated. Experimental results obtained with Kallirontron as amplifier are included.

TRUSSES

Tregillus Type

The Tregillus Truss, H. G. Tregillus. Eng. World, vol. 16, no. 7, May 1920, pp. 397-400, 11 figs. Combination of arch and Bollman truss.

TUBING

Copper and Brass, Manufacture of

Making Seamless Copper Tubing. Iron Trade Rev., vol. 66, no. 9, Feb 26, 1920, pp. 638-641, 7 figs. Plant for producing seamless copper or brass tubing, recently placed in operation by United States Copper Products Corp., Cleveland.

Light Steel, Manufacture

Light Steel Tubing Manufacture and Markets. Raw Material, vol. 2, no. 4, April 1920, pp. 147-150, 5 figs. Manufacturing details of light steel tubing, and methods of welding steel tubing seams.

TUNGSTEN

Radiation at White Heat

A Study of the Constitution of the Corpuscular Radiation Emitted from Tungsten at White Heat (Zur Frage nach der Konstitution der von Wolfram bei Weissglut ausgesandten Korpuskularstrahlung), H. Baerwald. Berichte der deutschen physikalischen Gesellschaft, vol. 21, no. 13-14, July 30, 1919, pp. 474-478, 4 figs. Writer gives account of investigation which, he claims, is a convincing argument in favor of the Stark theory (Jahrb. f. Rad. u. Elektr., no. 15, 1918), in which it is stated that radiation from wires at white heat is similar to that from canal rays. Report from Physical Inst. of the Technical High School at Darmstadt.

TUNGSTIC ACID

Manufacture

The Manufacture of Tungstic Acid (Die Herstellung von Wolframsäure), O. Kausch. Edel-Erden u. -Erze, vol. 1, no. 9, Feb. 1, 1920, pp. 97-99. Review of numerous American and European processes for the manufacture and purification of tungstic acid.

TUNNELS

Lining of

Notes on Tunnel Lining, S. Johannesson and B. H. M. Hewett. Proc. Am. Soc. Civil Engrs., vol. 46, no. 3, Mar. 1920, pp. 426-460, 13 figs. Causes for distortion and displacements of tunnel linings are discussed, and modifications of existing practice are suggested for avoiding them.

Vehicular, Hudson River

Hudson River Vehicular Tunnel, John F. O'Rourke. Public Works, vol. 48, no. 17, May 8, 1920, pp. 406-408. Writer explains nature of clay in bed of river as he found it in building tunnels therein, and proposed method of replacing soft material by depositing clay from above; also concrete block method of construction.

N. Y.-N. J. Commissions Reject Concrete Blocks for Tunnel. Eng. World, vol. 16, no. 7, May 1920, pp. 401-405, 8 figs. Report to New York-New Jersey Joint Tunnel Commissions comparing two- and three-line tunnels. Two-way cast-iron lined tunnel was selected.

The World's Greatest Vehicular Tunnel, Robert G. Skerrett. Sci. Am., vol. 122, no. 19, May 8, 1920, pp. 510-528 and 528-529, 4 figs. Structural features of New York-New Jersey project. From report of chief engineer of New York State Bridge and Tunnel Commission and New Jersey Interstate Bridge and Tunnel Commission.

Water, Repairing

Method of Repairing Water Tunnel with Cement Gun. Eng. & Contracting, vol. 53, no. 19, May 12, 1920, pp. 534-536, 2 figs. Repairing 120-ft. section of defective pressure tunnel on main supply line of Water Department of Tacoma, Wash., with steel reinforcement and gunite.

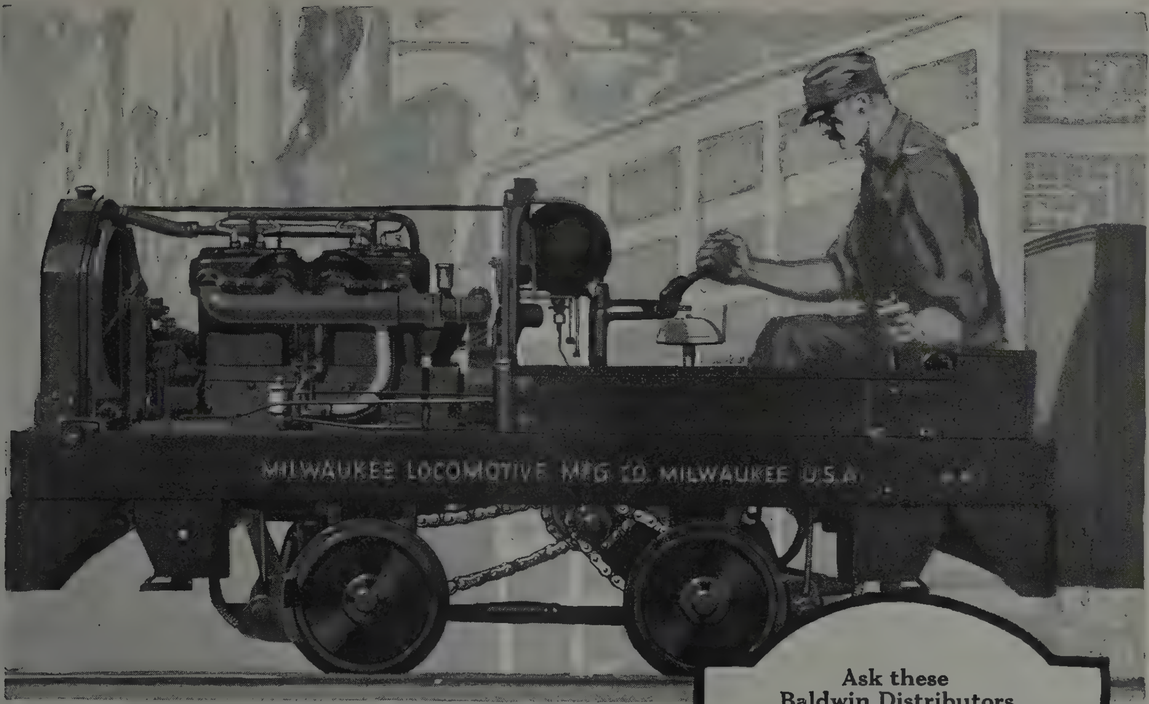
V

VACUUM TUBES

Electric Discharges in

High-Vacuum Discharge (Zur Hochcakuumentladung), J. E. Lilienfeld. Annalen der Physik, vol. 61, no. 3, Feb. 3, 1920, pp. 221-263, 9 figs. For the investigation of high-vacuum discharge in cylindrical paths writer employs subtraction method, instead of the older method in which exploring sounds are used, on tubes sealed off from pump in three different ways. Tables giving results of experiments, and bibliography are included.

[See also THERMIONIC VALVES; TRIODE VALVES.]



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Montreal, Toronto, Winnipeg, Can.	Lyman Tube & Supply Co. Limited.

GENUINE BALDWIN CHAINS

ENGINEERING INDEX (Continued)

VANADIUM

Recovery from Iron Slags

The Recovery of Vanadium from Iron Slags (Die Gewinnung des Vanadins aus Schlacken), Gustav Fester. Edel-Erden u.-Erze, vol. 1, no. 4, Nov., 1919, pp. 42-43. Describes trituration with sulphide of sodium and with soda and saltpeter.

VAPORS

Tension, Measurement of

An Apparatus for Measuring the Vapour Tensions of Volatile Liquids, A. V. C. Fenby. Chem. Age., vol. 2, no. 45, Apr. 24, 1920, pp. 434-435, 1 fig. Apparatus consists of two similar barometer tubes of special construction fixed to suitable stand and connected at their lower ends by thick-walled rubber tubing to mercury reservoir which can be raised or lowered. One of these tubes is used as barometer and the other as vapor tension tube.

Theory of

The Theory of Vapors (Zur Theorie der Dämpfe), E. Wertheimer. Berichte der deutschen physikalischen Gesellschaft, vol. 21, no. 13-14, July 30, 1919, pp. 435-453, 4 figs. Modification of kinetic theory is developed from experiments. It is said that translatory velocity of ponderable bodies in vacuum has nothing to do with temperature, but is determined by the frequency and force of the collisions, and the temperature itself depends upon the emitted radiation energy caused by the interruption of motion. Consequences of this aspect of the kinetic theory are pointed out.

VIADUCTS

Flat-Slab Construction

An Interesting Type of Flat Slab Construction. Ry. Age, vol. 68, no. 17, April 23, 1920, pp. 1233-1235, 5 figs. Concrete viaduct of flat-slab type reinforced in four directions, being built by Delaware, Lackawanna & Western to carry roadway over tracks, in separation of grades of Newark Turnpike and tracks.

VIBRATIONS

Machine

The Insulation of Machines for the Avoidance of Noises and Shocks (Isolierung von Maschinen zur Vermeidung von Geräuschen und Erschütterungen), Alfred Schacht. Elektrotechnischer Anzeiger, vol. 36, no. 154-155, Dec. 25, 1919, pp. 731-732, 2 figs. Describes two groups of vibrations generated by every machine during its operation which, it is claimed, must be considered separately when taking precautionary measures for insulation of point of vibration.

VOLTAGES

Standard

Standard Voltages (Normalspannungen). Elektrochemische Zeitschrift, vol. 26, no. 8-9, Nov.-Dec., 1919, pp. 91-94. Table of standards for the working voltage of electric plants of over 100 volts, adopted by the Assn. of German Electrotechnical Engrs.

W

WALLS

Heat Insulation of

A Simple and Practical Method for Determining the Heat Insulation of Different Types of Building Construction (Ein einfaches, praktisches Verfahren zur Bestimmung des Wärmeschutzes verschiedener Bauweisen). Karl Hencky. Zeitschrift für die gesamte Kälte-Industrie, vol. 26, no. 11, Nov., 1919, pp. 85-88, 3 figs. Method of determining heat permeability of walls which, it is claimed, is especially adapted to testing walls of finished houses.

WARSHIPS

U. S. S. Idaho

U. S. S. Idaho, Henderson B. Gregory. Jl. Am. Soc. Naval Engrs., vol. 32, no. 1, Feb. 1920, pp. 99-133. Characteristics: Length between perpendiculars, 600 ft.; breadth, molded, 97 ft.; depth, molded, 46 ft. 3½ in.; draught, mean, 30 ft.; displacement, 32,000 tons; main battery, twelve 14-in. guns arranged in four three-gun turrets along center line of vessel; secondary battery, fourteen 5-in. rapid-fire guns for torpedo defence; torpedo equipment, four 6.8-meter by 21-in. submerged torpedo tubes; propelling machinery. Parsons turbines driving four lines of shafting; speed, 21 knots.

WASTE PREVENTION

Woodworking Plants

Controlling Wastes in Woodworking Plants, Carle M. Bigelow. Indus. Management, vol. 59, no. 5, May 1920, pp. 377-383, 7 figs. Methods and practice for utilizing large pieces of scrap, economical burning of chips, shavings and the like, and determining percentages of waste.

WATER HAMMER

Calculation of

Calculation of Water Hammer in Conduits Formed of Two or Three Sections of Different Diameters (Calcul du coup de bélier dans les conduites formées de deux ou de trois tronçons de diamètres différents), Ed. Carey. Bulletin Technique de la Suisse Romande, vol. 46, no. 8, Apr. 17, 1920. pp. 85-88, 2 figs. Formula expressing transmission of pressure in case of sudden shut off of valve. (Continuation of serial.)

Study of Water Hammer in Metallic Conduits Under Pressure (L'étude des coups de bélier dans les canalisations métalliques sous pression). Houille Blanche, vol. 19, no. 37-38, Jan.-Feb. 1920, pp. 6-12, 17 figs. Account of experimental research conducted to determine amplitude of uneven harmonics. (Continuation of serial.)

WATER SOFTENING

Hot Process

The Hot-Process Water Softener, George H. Gibson. Chem. & Metallurgical Eng., vol. 22, no. 19, May 12, 1920, pp. 899-902, 4 figs. Study of rate of sedimentation of lime and magnesia precipitates during softening at low and high temperatures. Plant equipment: reagent proportioner, tanks and filter.

WATER SUPPLY

Groundwater Determination

Hydrologic Preparatory Work and Quantity Determination in Connection with Groundwater Supplies (Ueber hydrologische Vorarbeiten und Mengenbestimmung bei Grundwasserversorgungen), O. Smreker. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 12, Mar. 20, 1920, pp. 282-283. Discussion of G. Thiem's article on Hydrologic Preparatory Work for the Ground-Water Supply of the City of Danzig. Writer claims that Thiem's deductive method for quantity determination is unreliable. A brief reply from Thiem is appended.

Submerged Pipe Line

Repairs to Twelve-Inch Submerged Pipe Line, Patrick Quilty. Fire & Water Eng., vol. 67, no. 16, April 21, 1920, pp. 831-833 and p. 847, 5 figs. Installation of and subsequent repairs to main supplying North Brother Island, New York City.

WATER TANKS

Reinforced-Concrete

Reinforced Concrete in Chile. Concrete & Constructional Eng., vol. 15, no. 4, April 1920, pp. 227-233, 3 figs. Details of reinforced-concrete water tank of 15,000 metric tons capacity.

WATER WORKS

Chicago

Plan of Chicago's Water System—1920-1955, P. S. Combs. Eng. World, vol. 16, no. 7, May 1920, pp. 379-387, 6 figs. Intakes in Lake Michigan.

Sedimentation Basins

New Intake and Sedimentation Basin at Sarnia, F. W. Thorold. Can. Engr., vol. 38, no. 18, Apr. 29, 1920, pp. 413-416, 8 figs. One of nineteen concrete basins is used for screen house and others for sedimentation. Wooden form for intake structure was sunk to depth of 47 ft. and filled with concrete.

WATT-HOUR METERS

Friction Determination

A Simplified Method for the Determination of the Friction in Watt-Hour Meters (Vereinfachte Methode zur Bestimmung der Reibungsgrössen bei Motorzählern), G. Hommel. Elektrotechnik u. Maschinenbau, vol. 38, no. 8, Feb. 22, 1920, pp. 81-83. Method for determining the mean friction moment of a watt-hour meter —for example, for determining number of revolutions between stoppage and full load.

Locomotive Fireboxes

Methods of Welding Locomotive Fireboxes, George L. Walker and R. T. Peabody. Boiler Maker, vol. 20, no. 4, Apr. 1920, pp. 99-103, 37 figs. Discusses methods of restoring firebox edges by welding and offers suggestions for facilitating repairs. (Concluded.)

WAVES

Electromagnetic

The Electromagnetic Compound Plane Wave (Die elektromagnetische Zweimittel-Planwelle), Karl Uller. Jahrbuch Zeitschrift für drahtlose Telegraphie u. Telephonie, vol. 15, no. 2, Feb. 1920, pp. 123-152. Writer claims to have discovered a new manner of wave propagation whose characteristics are not recognizable under existing hypotheses; he states that every cable current and every alternating current is a wave of this type, and that every spark discharge, atmospheric discharge, etc., emits such a wave.

WELDING

Jigs and Fixtures for

Modern Welding and Cutting—XX, Ethan Viall. Am. Mach., vol. 52, no. 13, Mar. 25, 1920, pp. 665-669, 13 figs. Welding jigs and fixtures used for repetition jobs.

[See also ELECTRIC WELDING, ARC; ELECTRIC WELDING, RESISTANCE; OXY-ACETYLENE WELDING.]

WELFARE WORK

Factory Doctor

Why a Factory Doctor's Salary Costs Less than Nothing, G. L. Howe. Factory, vol. 24, no. 4, Mar. 1, 1920, pp. 618-621, 2 figs. Writer claims medical supervision is not philanthropy, but a business proposition, and presents figures and facts to bear out his arguments.

WELLS

Recovery of Sand Pump

Recovering Lost Sand Pump from a Deep City Well, R. A. Campbell. Eng. World, vol. 16, no. 7, May 1920, pp. 416-418, 6 figs. Special hook was developed after taking impression of existing conditions by means of impression tool.

WIND TUNNELS

Balances for

Wind Tunnel Balances, Edward P. Warner and F. H. Norton. Nat. Advisory Committee for Aeronautics, no. 72, 1920, 40 pp., 19 figs. Comparative study of various types undertaken with a view to selecting balance for Langley Field wind tunnel. Balance selected was type used in National Physical Laboratory, distinguishing feature of which is carrying of whole balance on single pivot, thus permitting it to rock in two planes. Original design was slightly modified to permit measurements of larger forces.

WOOD

See AIRCRAFT CONSTRUCTION MATERIALS, Timber.

WORKMEN'S COMPENSATION

Attorney's Fees

Notices and Claims Under Compensation Acts —III, Chesla C. Sherlock. Am. Mach., vol. 52, no. 16, April 15, 1920, pp. 844-846. Concerning costs, particularly attorney's fees, in proceedings under Workmen's Compensation acts.

Laws on, Revision of

The Cost of Industrial Accidents, Royal Meeker. Monthly Labor Rev., vol. 10, no. 4, Apr. 1920, pp. 1-13. Plea is made for revising the compensation laws which have been enacted in the various states. These laws show, it is claimed, lack of uniformity in coverage and inexplicable inequalities in money and medical compensation. It is also urged that accurate and up-to-date statistics of industrial accidents causing physical injuries be kept in all states and territories.

Laws on, Scope of

Scope and Operation of the Workmen's Compensation Laws of the United States, Lindley D. Clark. Monthly Labor Rev., vol. 10, no. 4, Apr. 1920, pp. 14-32, 1 fig. on supp. plate. Comparative study of laws of the various states.

X

X-RAYS

Action Upon Plates

The Behavior of Photographic Plates to X-Rays, O. Bloch and F. F. Renwick. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 40-46, 7 figs. Account of work done in Research Laboratories of Ilford, Limited, on action of X-rays upon gelatine dry plates.

Tubes

A Method of Testing an X-Ray Tube for Definition, J. Brooksbank. Trans. Faraday Soc., vol. 15, part 2, Feb. 1920, pp. 66-71, 5 figs. on 4 supp. plates. Method of determining size of focal spot required is suggested which consists in taking series of radiographs of two uniform parallel wires of given thickness and placed definite distance apart.

[See also RADIOMETALLOGRAPHY.]

Z

ZINC METALLURGY

Reactions

Study of Metallurgical Reactions of Zinc Sur l'étude des réactions de la métallurgie du zinc), M. M. Lebarchands. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 13, March 29, 1920, pp. 805-807. Experiments to study possibility of direct action of zinc oxide on coal in atmosphere of pure nitrogen.

Mechanical Engineering

The Journal of The American Society of Mechanical Engineers

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C. 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

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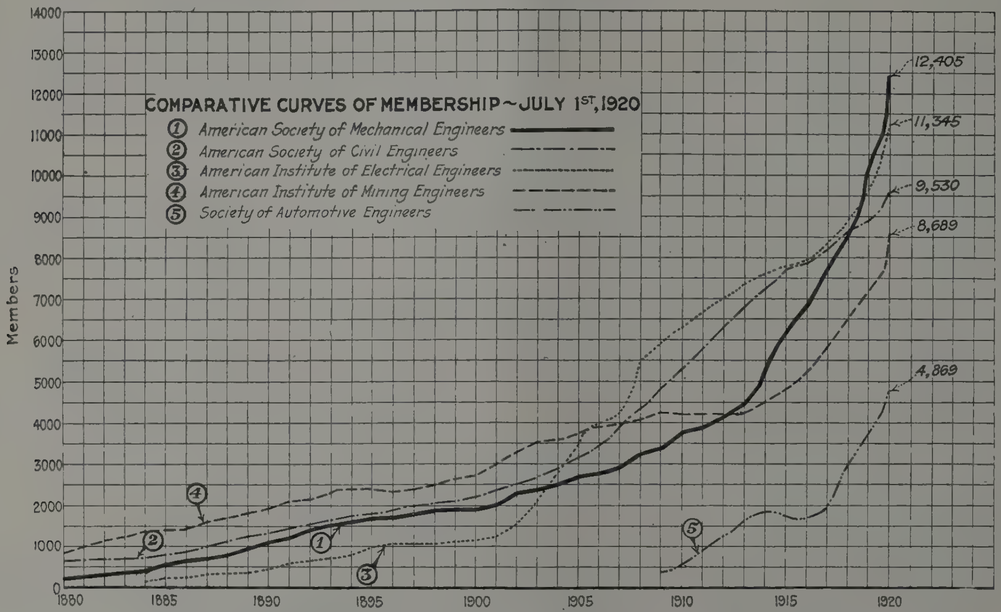
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 8, 1918.

The Value of Membership in Engineering Organizations

ENGINEERS are coming more and more to appreciate the value of association with their fellow-engineers. The individual engineer, however, can only take his proper place in the community and receive the recognition that is due him through such organizations as the local societies and clubs and the great national organizations which are devoted to the advancement of the various branches of engineering. In union there is strength.

The greatest step, however, toward the attainment of that professional unity so long desired has just been taken. A general organization, nation-wide in its scope and representing the entire engineering profession in the same way that the American Bar Association and the American Medical Society represent the legal and medical professions, and the United States Chamber of Commerce the business men, has just been founded by delegates of 71 technical organizations who met in Washington on June 3 and 4. The object of the new organization could not be higher: *Service to others and the furthering of the interest of the public through the use of technical knowledge and engineering experience.*



Curves Showing Growth of Membership in the National Engineering Societies

These Curves Show How Engineers Are Grasping the Opportunities for Participation in the National Engineering Movements

Resolutions were also adopted endorsing:

(*a*) An increase in the salaries of teachers in engineering colleges

(*b*) The prompt enactment by Congress of legislation necessary to give effect to the principles of the report submitted by the Reclassification Committee

(*c*) The bill for the creation of a Department of Public Works to embrace the constructional and engineering activities of the National Government.

The formation of this organization, which will be known as The Federated American Engineering Societies, has been characterized by the engineering press as "the biggest item of news of its kind in the engineering history of the country." Membership in the new organization is limited to national, local, state, regional, and allied technical organizations and affiliations. *There are to be no individual memberships.* Each organization will be entitled to one voting delegate for each thousand members. This provision but emphasizes for the individual engineer the growing importance of belonging not only to his local engineering organization, but to the National Society covering his specialty as well.

Your mechanical engineering associate—not a member of the A. S. M. E.—will welcome a suggestion from you that he participate in the work of the Society.

Applications received by August 16 should be acted upon by November, and those elected, upon the payment of initiation fee and dues to October 1921, totaling for voting members only $37.50 ($23.34 for Juniors) payable December 1, will be entitled to:

- (*a*) Attend the Annual Meeting, December 7-10, 1920, admission to which may be restricted to members
- (*b*) MECHANICAL ENGINEERING, The Journal of The American Society of Mechanical Engineers
- (*c*) A copy of the 1921 Year Book and listing therein
- (*d*) A copy of the 1920 Transactions
- (*e*) A copy of Condensed Catalogues of Mechanical Equipment.

In addition to the Annual and Spring Meetings (the latter at Chicago, Ill., in 1921), meetings will be held regularly beginning next October in 42 centers throughout the United States. These centers and the secretaries of the committees at these places at present are as follows:

Akron, Ohio, E. P. Roberts, Room 21, 80 South Main St.
Atlanta, Ga., R. S. King, Georgia School of Technology.
Baltimore, Md., A. G. Christie, Johns Hopkins University.
Birmingham, Ala., J. A. Sirnit, Brown-Marx Building.
Boston, Mass., D. K. Dean, 88 Broad St.
Bridgeport, Conn., James Coulter, Automatic Machine Company.
Buffalo, N. Y., W. W. Boyd, 1888 Elmwood Ave.
Chicago, Ill., J. D. Cunningham, 565 Washington Boulevard.
Cincinnati, Ohio, J. T. Faig, Ohio Mechanics Institute.
Cleveland, Ohio, C. H. Day, 14th Floor, Hotel Statler.
Colorado, Wm. Lester, Vulcan Iron Works, Denver.
Columbus, Ohio, Wm. T. Magruder, Ohio State Univsity.
Detroit, Mich., M. W. Taber, 1858 Penobscot Building.
Eastern New York, J. L. Hughes, Watervliet Arsenal, Watervliet, N. Y.
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Hartford, Conn., W. C. Beekley, Whitlock Coil Pipe Co.
Houston, Texas, H. W. Fletcher, Hughes Tool Company
Indianapolis, Ind., Chas. Brossman, 1503 Merchants Bank Building.
Los Angeles, Cal., R. W. Lacy, 600 Washington Building.
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Oregon, E. W. Lazell, 537 Railway Exchange Building, Portland.
Philadephia, Pa., Chas. Penrose, 611 Chestnut St.
Pittsburgh, Pa., Kenneth F. Treschow, 586 Union Arcade Building.
Providence, R. I., J. D. Guillemette, 740 Grosvenor Building.
Rochester, N. Y., F. A. Collins, Jr., 29 Elizabeth St.
St. Louis, Mo., Walter E. Bryan, United Railways Co.
San Francisco, Calif., J. A. Kinkead, Rialto, Building.
Syracuse, N. Y., L. J. Schuyler, 615 Euclid Ave.,
Toledo, Ohio, John B. Nordholt, The Toledo Steel Castings Company.
Utica, N. Y., B. E. White, 222 Genesee St.
Virginia, A. H. Warx, Alco Plant, American Alco Co., Richmond.
Washington, D. C., A. R. Cheyney, Electrical Experimental Aide, Bureau of Steam Engrg., U. S. N.
Washington State, E. O. Eastwood, University of Washington, Seattle.
Waterbury, Conn., J. R. Putnam, Waterbury Clock Co.
Worcester, Mass., Chester T. Reed, Reed & Prince Manufacturing Co.

Preliminary Request for Membership

(Date)..............................

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York.

Desiring admission to The American Society of Mechanical Engineers, I submit the following:

Born at.................... (City) .... (State) .... (Date)

Education.................... (Name of School)

College Degree.................... (College) .... (Year)

Present Position.................... (Title)

.... (Name of Concern)

I hereby agree that I will subsequently sign the prescribed application for membership issued by the Society, and comply with all the conditions and provisions thereof.

.... (Signature of Applicant)

Mailing Address..............................

To Every Member of the A. S. M. E.

Solemn Warning!!!!

THE 1919 Annual Meeting taxed the capacity of the Engineering Societies Building and the crowd will be still larger for the 1920 meeting. Six of the new Professional Sections will hold sessions covering the vital questions in their field. These well-planned programs with the ever-popular social and entertainment features guarantee an attendance that is causing the Committee on Meetings and Program some concern. Serious consideration must be given to a limitation of guest privileges or the renting of larger halls for some of the sessions.

This warning is double: FIRST—If you have non-member engineering friends who would benefit from attendance at the Annual Meeting and whom you are planning to bring, it would be better to play safe and file their applications for membership *now*. SECOND—Put a note in your tickler for October, to check up the Annual Meeting program, which will be announced at that time, and determine whether you will be on hand December 7-10 at the Meeting. Then make your hotel reservations, because New York hotels are always crowded in December.

The Professional Sections on Fuel, Industrial Engineering, Machine Shop, Power, Railroads and Textiles are the ones planning Annual Meeting sessions. If you have a paper in process or under consideration on any of these subjects, advise the Secretary of the Society at once, so that your paper may have consideration in the arrangement of the program.

Contributors and Contributions in This Number

Metal Castings—A Group of Papers on the Usefulness and Limitations of Various Types of Castings

At the Spring Meeting of the A.S.M.E. the Society's Sub-Committee on Foundry Practice presented a symposium on castings which outlined in brief form the latest available information as to the present state of the art of foundry practice. An abstract of the papers of this symposium appears as the leading article of the present issue. It treats under separate heads malleable castings, die castings, aluminum castings, steel castings, gray-iron castings, and brass and bronze castings, and in general each paper discusses the special properties of a particular kind of casting and where it is to be preferred to other forms of cast metal. The authors of the various papers are acknowledged authorities and their contributions can be accepted in the light of a thoroughly reliable report.

Pipe Lines for Transporting Natural Gas, By Clifford E. Brock, Bartlesville, Okla.

With the development of the natural-gas industry there has been a corresponding change in the method of its transportation. The first line, laid in Pennsylvania in 1872, was constructed of wood. Later, as metal lines came into common use, the chief difficulty encountered was that of properly joining one pipe with another. Small screw lines were first used. These were followed by leaded-joint lines, which type of connection in turn developed into the rubber-gasket joint of the present day. Welded lines have also been employed. In his paper Mr. Brock outlines the development of these various methods of constructing pipe lines, giving in connection therewith the results of tests made to determine their relative strength and reliability.

McCook Field and American Aeronautics, By Leon Cammen, New York, N. Y.

During the war McCook Field was the center of the engineering activities of the Army Air Service and as such it was the scene of great developments in the art and science of aeronautics. The chief work in the development of the Liberty motor, for instance, was carried on at McCook Field, and now, even though there is less activity at this aeronautical Detroit of the United States, the character and importance of the work carried on is as great as ever.

In his paper Mr. Cammen traces the inception of the great flying field and describes the nature of the work now being done there. Chief among the problems which now claim the attention of the aeronautical engineers are those concerned with the variable-pitch propeller, the development of suitable aeronautical instruments, and research growing out of flight at high altitudes. All of these are discussed in a practical manner by Mr. Cammen. McCook Field as it now stands represents a powerful stimulus to the development of aeronautics in this country, and it is unquestionably destined to play a large part in the advancement of that art.

The Engineer and the Woodworking Industry, By Thomas D. Perry, Grand Rapids, Mich.

The woodworking industry is one of the greatest in this country and one in which it might appear that the engineer took a prominent part. Such, however, is quite contrary to the actual facts in the case, for this great industry is urgently in need of engineering skill of the highest type. With a view of outlining the scope of the woodworking field and presenting some of the engineering problems involved therein, Mr. Perry, vice-president and manager of the Grand Rapids Veneer Works, has prepared an article which appears in this issue. He discusses the problems involved from the conversion of timber and logs into lumber until that lumber finally appears in its finished form as furniture, house trim, caskets, pianos, etc. The paper does not purpose to be an exhaustive presentation of this vital subject, but merely a statement of facts.

An Investigation of Compressed-Spruce Pulleys, By George S. Wilson, Seattle, Wash.

To the current number Professor Wilson, of the University of Washington, has contributed a paper outlining the results of a research on the practicability of manufacturing pulleys from native spruce. In conducting the research special attention was given to a determination of the factors influencing the carrying capacity of compressed-spruce pulleys and a comparison of such pulleys with other commercial types. The paper contains curves and tables and a brief description of the method of conducting the tests.

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 42 August 1920 Number 8

Metal Castings[1]

A Group of Papers on the Usefulness and Limitations of Various Types of Castings Contributed by the A. S. M. E. Sub-Committee on Foundry Practice

MECHANICAL engineers are called upon to decide or advise on the selection of the proper kind of casting for a given piece of construction and should therefore have available reliable information as to the present state of the art in foundry practice. The following papers are intended to outline the special properties of the particular kinds of casting of which they treat and to explain where they are to be preferred to other forms of cast metal. They also review what is actually being done so that engineers and designers may know what they should be able to secure from first-class commercial foundries at the present time. In the preparation of the papers the endeavor has been to avoid giving information on the art of making castings, the specifications or methods of testing castings or the production of the metals from which the castings are made.

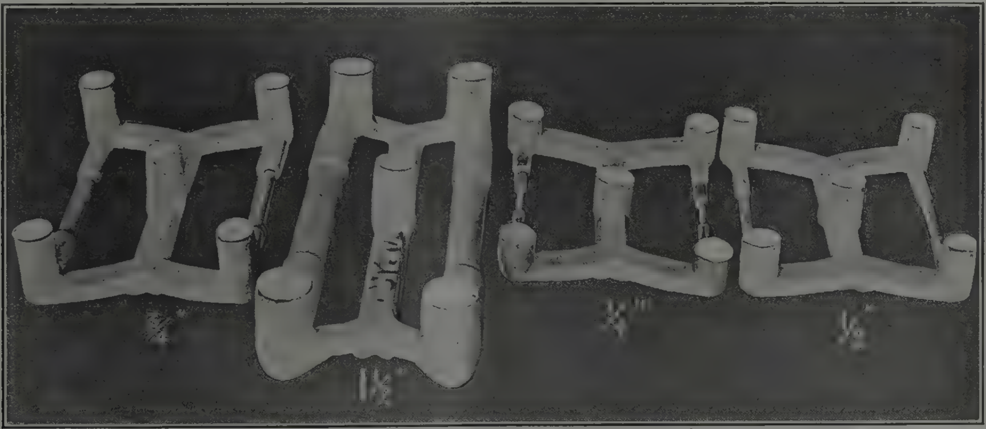

FIG. 1 METHOD OF CASTING ROUND TEST BARS OF VARIOUS DIAMETERS

ALUMINUM CASTINGS

BY ZAY JEFFRIES,[2] CLEVELAND, OHIO

THE aluminum-castings industry can hardly be said to be more than fifteen years old. It is true that castings were made prior to 1905, but in such small quantities as to be insignificant in comparison with the present magnitude of the industry. The annual production of aluminum at the present time is about three hundred million pounds. The percentage of this used in castings is not definitely known, but it is estimated at about one-half the world's production.

The aluminum-casting art has developed largely by rule-of-thumb methods and even as recently as 1917 the quality of castings was so uncertain that aeroplane manufacturers and aviators had to be reassured of the reliability of the metal for aeroplane construction. In May, 1917, at the request of Messrs. Manley and Cardullo of the Curtiss Aeroplane Company, an investigation was made of the properties of aluminum castings then being used for aeroplane crankcases and other parts. It was found that the quality was very poor, the physical properties being neither uniform nor sufficiently high.

Immediate steps were taken to introduce technical control in the foundries to insure against wrong metal compositions and abuse of metal during the melting operations, and also to insure the maintenance of the proper pouring temperature. The results were very satisfactory, as is evidenced by the production record of Liberty engine castings in which a minimum tensile strength of 18,000 lb. per sq. in. was specified and the rejection for failure to pass specifications was practically nil. Even in such highly stressed parts as those in the Liberty engine, no failures in service have come to the author's attention.

ALUMINUM ALLOYS FOR CASTINGS

The principal aluminum alloy used for castings in the United States consists of about 92 per cent aluminum and 8 per cent copper and is generally known as Aluminum Company of America's No. 12 alloy or S. A. E. specification No. 30. This alloy when cast in a ½-in. test bar in green sand and tested without machining off the skin should give an average tensile strength of about 20,000 lb. per sq. in. and an average elongation of about 1.5 per cent in 2 in. A modification of this alloy having somewhat better physical properties is now finding considerable favor in castings for the automotive industry. This alloy has an analysis of 7.5 per cent copper; 1.5 per cent zinc; 1.2 per cent iron, and the remainder aluminum. The tensile strength of this alloy will average about 21,000 lb. per sq. in. and the elongation will be somewhat greater than that of No. 12 alloy.

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[1] Abstracts of papers presented at the Castings Session of the Spring Meeting, St. Louis, May, 1920, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

[2] Director of Research Laboratory, Aluminum Castings Company, Cleveland, Ohio.

S. A. E. Specification No. 32 is another alloy of aluminum and copper which finds considerable use, especially in parts which need to be water-tight. This alloy contains from 11 to 13.5 per cent copper, the remainder being commercial aluminum.[1] Its tensile strength when the test bar is cast in green sand about ½ in. in diameter and broken without machining off the skin should show an average of 20,500 lb. per sq. in. and the elongation will be practically nil. This alloy is used for carburetors, pumps, manifolds, radiators, engine cylinders, etc.

Another aluminum-copper alloy containing about 5 per cent copper is used for cast automobile bodies. This alloy has an average tensile strength of about 18,000 lb. per sq. in. and an average elongation of 3.0 per cent.

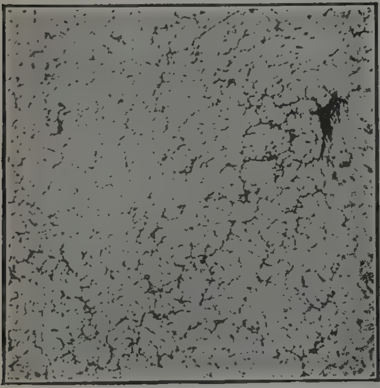
Fig. 2 Grain Size in a Round Test Bar of 8 Per Cent Copper Alloy, 1¼ in. in diameter, Cast in Green Sand. Magnification 50 Diameters

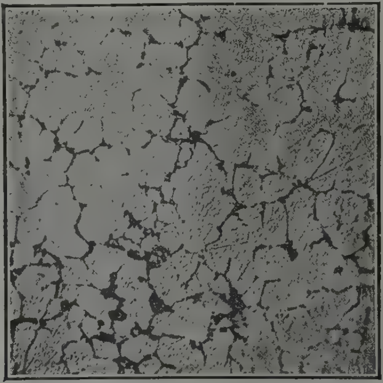
Fig. 3 Grain Size in a Round Test Bar of 8 Per Cent Copper Alloy, 1½ in. in diameter, Cast in Green Sand. Magnification 50 Diameters

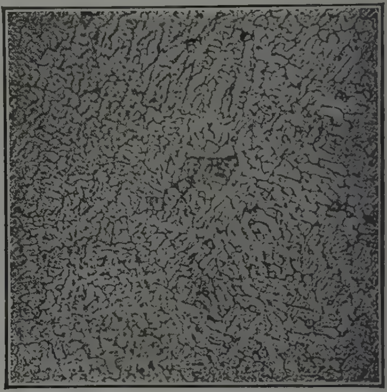
Fig. 4 Micrograph of Aluminum Alloy Containing 8 Per Cent Copper, Showing Grain Size Produced by Casting Cylinder 1¼ in. Diam. in Green Iron Mold. Magnification 50 Diameters

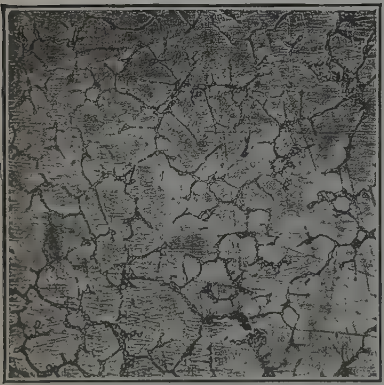
Fig. 5 Micrograph of Aluminum Alloy Containing 8 Per Cent Copper, Showing Grain Size Produced by Casting Cylinder 1¼ in. Diameter in Green Sand. Magnification 50 Diameters

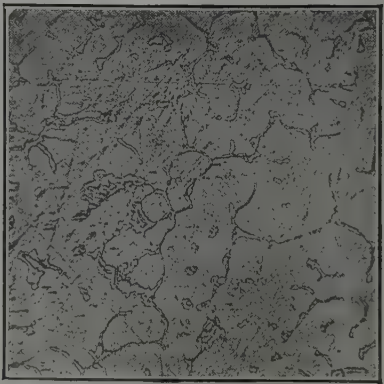
Fig. 6 Specimen Shown in Fig. 4 but at Higher Magnification to Show Structure of Network Surrounding the Grains. Magnification 250 Diameters

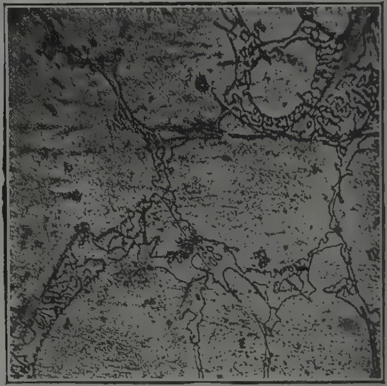
Fig. 7 Specimen Shown in Fig. 5. Higher Magnification Brings Out the Structure of the Network Around the Grains. Magnification 250 Diameters

For pistons cast in permanent molds an alloy containing 10 per cent copper, 1.25 per cent iron, 0.25 per cent magnesium is extensively used. This alloy gives a good wearing surface both for the piston against the cylinder wall and for the bearing of the wristpin in the bosses. The pistons and camshaft bearings for the Liberty engine were made from this alloy, the former being cast in permanent molds.

While the aluminum-copper alloys have been used mostly in the United States, light alloys containing zinc have been used more extensively abroad. The most common alloy in use in England for sand castings contains 13.5 per cent zinc and 2.75 per cent copper, the remainder being commercial aluminum. The specific gravity of this alloy is 3.0 and its tensile strength when cast in sand should be over 25,000 lb. per sq. in. and the elongation should exceed 1 per cent. In England the test bars of this alloy are cast in chill molds and the minimum physical-property requirements are a tensile strength of 11 long tons (24,640 lb.) per sq. in. and an elongation of 4 per cent. This alloy is used in England as a substitute for our No. 12 alloy.

An alloy containing 10 per cent zinc and 2.5 per cent copper is put out in ingot form in England by the British Aluminum Company. This alloy should have a tensile strength of more than 22,000 lb. per sq. in. and an elongation of more than 2 per cent in 2 in.

Aluminum Manufactures, Inc., use an alloy containing 7 per cent zinc, 2.75 per cent copper and 1.5 per cent iron. This alloy has an average tensile strength of about 27,500 lb. per sq. in. when cast in green sand and an average elongation of about 4.5 per cent.

Zinc is added to aluminum up to 33 per cent. As the zinc increases up to this amount the tensile strength increases and the elongation decreases. The 33 per cent zinc alloy has been used considerably in the past but it is too brittle to find extensive employment in the industries in competition with more ductile alloys which also have lower specific gravities.

At the Westinghouse Electric and Manufacturing Company an alloy composed of 95 per cent aluminum and 5 per cent magnesium is used for starting-motor frames and other automobile work where extreme lightness and good machining qualities are essential. The specific gravity of this alloy is 2.47, the average tensile strength about 27,000 lb. per sq. in., and the elongation about 3 per cent.

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[1] Commercial aluminum always contains iron and silicon in amounts of 0.25 per cent and upward according to the grade of ingot.

At the United States Navy Yard, Washington, D. C., an alloy containing 2 per cent copper and 1 per cent manganese is used for all aluminum-casting work. It is used for parts for gun sights, optical instruments, loading-tray sights for naval mounts, mine-laboratory experimental work, parts for nitrating machinery for use in the manufacture of powder, etc. This alloy has a tensile strength of about 18,000 lb. per sq. in. and an elongation of about 8 per cent. Its proportional limit is very low, often not exceeding 2000 lb. per sq. in.

An alloy containing 98 per cent commercial aluminum and 2 per cent manganese is also used for certain aluminum castings which should resist the corrosive action of chemicals used in rubber molding.

PHYSICAL PROPERTIES OF ALUMINUM AND ITS ALLOYS

Hardness. The Brinell hardness of pure aluminum is about 25 and that of the hardest aluminum alloy is more than 120. Where hardness is the controlling factor, any value between 25 and 120 can be produced.

Coefficient of Expansion. The coefficient of expansion of pure aluminum is about 0.000025 per deg. cent. The coefficient of expansion of the alloys varies between 0.000022 and 0.000027. Alloys containing about 5 per cent magnesium have the higher coefficient of expansion and the high-copper alloys show the lower values.

Heat Conductivity. The heat conductivity of pure aluminum is about 0.50 K or about 48 per cent of the conductivity of copper at ordinary temperatures, and varies but slightly with temperature. The heat conductivity of aluminum alloys is less than that of the pure metal, varying between 25 per cent and 48 per cent of the conductivity of copper, the general rule being that the greater the percentage of alloying elements, the lower the heat conductivity.

Electrical Conductivity. The electric resistivity of pure aluminum is about 2.94 microhms per cubic centimeter. The electric resistivity of the alloys is higher than that of pure aluminum, ranging up to 5.70 microhms per cu. cm.

Melting Points. The melting point of pure aluminum is 658 deg. cent. The lowest melting points of the useful alloys range around 580 deg. cent.

Crystallization Shrinkage and Allowance for Pattern Shrinkage. The crystallization shrinkage of pure aluminum is about 5 per cent by volume, and a further 5 per cent decrease in volume takes place on cooling from the melting point to room temperature. The crystallization shrinkage is somewhat less in the alloys. The pattern shrinkage allowed for all aluminum alloys is 5/32 in. per ft.

Specific Gravity. The specific gravity of pure aluminum is about 2.7 and that of the alloys is not far from that calculated from the specific gravities of the various constituents. An alloy containing 95 per cent aluminum and 5 per cent magnesium has a specific gravity of about 2.47 and one containing 67 per cent aluminum and 33 per cent zinc a specific gravity of about 3.3. These represent minimum and maximum values for the usable aluminum-base alloys.

Modulus of Elasticity. The modulus of elasticity of aluminum is about 10,000,000 lb. per sq. in. Values as low as 8,500,000 and as high as 11,000,000 have been obtained.

GENERAL OBSERVATIONS ON ALUMINUM CASTINGS

Classes. Aluminum castings may be divided into three classes according to the method of manufacture, namely,

1. Sand Castings
2. Permanent Mold Castings
3. Pressure Die Castings.

Sand castings are so named because they are cast in either green or dry sand. The method of molding is very similar to that used for other metals except that the gates, risers and chills must be used to suit the particular properties of aluminum and its alloys. Such parts as crankcases for gas engines, oilpans, manifolds, steering-wheel spiders, transmission housings, differential carriers, etc., are usually cast in sand.

Permanent-mold castings are made in iron or other metal molds and consequently have a greater degree of chill than the sand castings. The physical properties of the various alloys vary in proportion to the degree of chill. Molds for the permanent-mold castings are provided with ample gates and risers for feeding, consequently the permanent-mold casting is non-porous as distinguished from the pressure die casting, which is always porous in the interior. As a general rule the permanent-mold process is limited to small parts with simple shapes.

Pressure die castings are considered in a paper on Die Castings presented at this session by Mr. Charles Pack.

Maximum and Minimum Weight. Aluminum sand castings have been regularly made weighing as high as 480 lb. each, but one of 150 to 200 lb. is usually considered a large casting. The minimum weight may be taken as 1 oz., but neither this weight nor 480 lb. should be considered as an extreme limit.

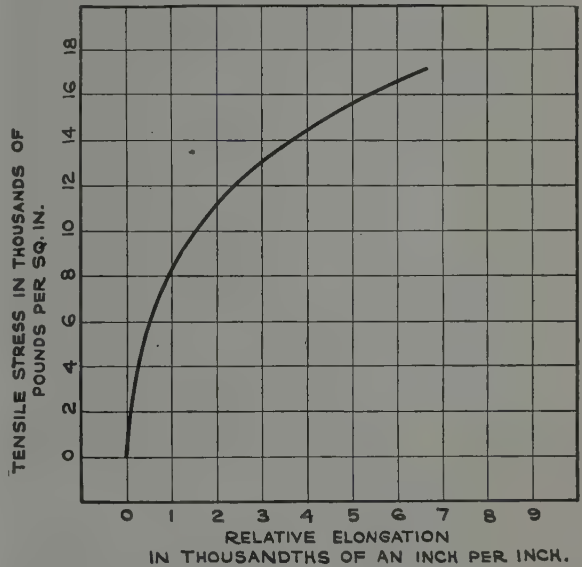

FIG. 8 STRESS-STRAIN DIAGRAM OF ALLOY CONTAINING 92 PER CENT ALUMINUM AND 8 PER CENT COPPER

In the permanent-mold process the maximum weight is about 20 lb. and the minimum weight about 1 oz. Permanent-mold castings have been made weighing as high as 150 lb. but these large castings should be considered as special.

Section Thickness. On gas-engine oilpans the walls should be 3/16 in. or more in thickness and on crankcases a wall thickness of 7/32 in. or greater is common practice. Fillets should have large radii, especially where heavy sections join thin sections. The best thickness on pipes, manifolds, etc., is ⅛ to 5/32 in. The minimum thickness on permanent-mold castings is from 3/32 in. to ⅛ in.

Finish. On large sand castings ⅛ in. should be allowed for finish and on bench work 1/16 in. A finish of 1/32 in. should be allowed for disk grind.

The finish on permanent-mold castings up to 3 in. in diameter, for example, pistons, should be about 0.075 in. on the diameter, and the finish on the piston head should be 0.045 in. The finish on permanent-mold pistons over 3 in. in diameter should be about 0.093 in.

Tolerances on Dimensions and Weights. In sand castings a tolerance of 1/32 in. in thickness should be allowed and in permanent-mold castings the tolerances are plus or minus 0.010 in. The weight tolerances on sand castings using metal-pattern equipment are plus or minus 3 per cent and with wood patterns plus or minus 5 per cent. The weight tolerances on permanent-mold castings are plus or minus 2 per cent.

Machining. For roughing cuts speeds of 500 to 700 ft. per min. and a feed of $\frac{1}{16}$ in. to 5/32 in. are recommended, according to the nature of the work. No lubrication is recommended for roughing. For extra fine finish a speed of about 125 ft. per min. is recommended, but speeds up to 600 ft. can be used and satisfactory finish obtained. For turning, the finishing feeds should be from 0.01 in. to 0.125 in., and for planing, up to 0.25 in. A good lubrication mixture for finishing is 70 parts kerosene and 30 parts lard oil.

Aluminum alloys take a fine finish by grinding. Good results have been obtained using a No. 40 grain crystolon wheel and a mixture of 10 per cent lard oil and 90 per cent water for lubrication. The grains of the crystolon wheel even when dislodged do not stick in the metal.

HEAT TREATMENT OF ALUMINUM-ALLOY CASTINGS

Aluminum castings, especially those containing copper, may have their volumes permanently changed by heat treatment. Also the hardness may be changed. These facts are taken into consideration in connection with the heat treatment of aluminum-alloy parts such as pistons which will have to operate at an elevated temperature. The pistons are given a heat treatment which will cause permanent growth to such an extent that no additional change of volume will take place during normal running.

EFFECT OF THICKNESS OF SECTION ON PHYSICAL PROPERTIES OF ALUMINUM ALLOYS

In general, the tensile strength and elongation of the aluminum alloys decrease as the thickness of the section increases. In the case of round test bars cast as shown in Fig. 1, the decrease in tensile strength in an alloy containing 8 per cent copper and 92 per cent aluminum is from approximately 25,000 lb. per sq. in. and 3 per cent elongation in the ¼-in. test bar, to 14,000 lb. per sq. in. and less than 1 per cent elongation in the 1½-in. test bar, with proportional intermediate values for the ½-in. and ¾-in. bars.

It appears that this alloy on account of its low elongation does not show up so well when tested in a large piece as would be indicated from the results obtained from small test bars machined from the larger pieces. For example, small test bars cut from the 1½-in. bars averaged about 19,000 lb. per sq. in. and the elongation was more than 1 per cent, whereas the large bars tested 14,000 lb. per sq. in. and less than 1 per cent elongation. The tensile strength of one of the zinc alloys described earlier decreases at an approximately linear rate from about 30,500 lb. per sq. in. in a ¼-in. test bar to 19,500 lb. in a 1½-in. test bar. Small bars cut from the 1½-in. bar tested about the same as the 1½-in. bar itself. The elongation of the zinc alloy decreases also with increase in thickness of section. It is thought that the greater ductility of this alloy is responsible for the similarity of results between the small test bars cut from the large bars and the large bars themselves.

The lower strength and ductility of the large sections are due to a combination of variation in grain size and soundness of the casting. The smaller sections are as a rule better fed during solidification and since they solidify more rapidly than the thicker sections, they are also finer-grained. Figs. 2 and 3 show the variation in grain size in the 8 per cent copper alloy when cast in ¼-in. and 1½-in. bars.

EFFECT OF RATE OF CHILL ON THE PHYSICAL PROPERTIES OF ALUMINUM ALLOYS

As a general rule, the more quickly aluminum alloys solidify the smaller the grain size and the higher the tensile strength and elongation. No. 12 alloy, for example, when cast in large sections in sand may have a tensile strength as low as 14,000 lb. per sq. in. and an elongation of less than 1 per cent. When cast in small sections in a chill mold its tensile strength may be 31,000 lb. per sq. in. and its elongation as high as 6 per cent. Figs. 4, 5, 6 and 7 show the effect of degree of chill on the structure of an alloy containing 92 per cent aluminum and 8 per cent copper.

FATIGUE RESISTANCE OF ALUMINUM ALLOYS

In sand-cast bars of No. 12 alloy the fatigue resistance as measured on the White-Souther machine is about 14,000 lb. per sq. in. maximum stress for 500,000 reversals and about 8500 lb. per sq. in. maximum stress for 16,000,000 reversals. The proportional limit of this alloy is about 5000 lb. per sq. in. The stress-strain curve departs very gradually from a straight line after the proportional limit is exceeded, as is shown in Fig. 8. It is believed that the proportional limit of the aluminum alloys does not represent a breakdown of the main metallographic constituent as in a single-component metal like wrought iron, but that it simply breaks some of the unfavorably situated, brittle aluminum compounds and thus causes slight permanent set. The fatigue life of the aluminum alloys is quite unusual, inasmuch as the safe limit seems to be equal to or higher than the proportional limit as measured by the extensometer. Chill-cast alloys are even better than the sand-cast alloys for fatigue resistance.

In a very comprehensive paper entitled Aluminum Alloys for Aeroplane Engines, by Prof. F. C. Lea, published by the Royal Aeronautical Society in 1919, fatigue tests on various aluminum alloys are reported, together with stress-strain diagrams. These tests show a minimum fatigue range in the Wohler test of 12,000 lb. per sq. in. (— 6000 to + 6000) for 12,000,000 reversals on an alloy containing 12 per cent copper. The proportional limit of this alloy was 5000 lb. per sq. in., although the amount of permanent set up to 6000 lb. was very slight.

GENERAL CONSIDERATIONS REGARDING USE OF ALUMINUM CASTINGS

As an engineering metal aluminum is in a class by itself because of its low specific gravity. Its use is determined by many factors, among which are the following:

a Where lightness is of prime importance. Aluminum in sheet form has about seven times the stiffness of steel for equal weights. For a given rigidity in any metal structure aluminum will weigh less than any other metal used in engineering. For such parts, therefore, as aeroplane engine crankcases, camshaft housings, oil-pans, etc., where lightness and rigidity are of prime importance, aluminum alloys find extensive use.

b In the manufacture of gas-engine crankcases it is found that the aluminum castings can be machined about three times as rapidly as cast-iron parts, and consequently the first cost of plant installation and labor cost of machining is greatly decreased by the substitution of aluminum for cast iron. The lightness of the crankcase is the chief advantage because the weight of the engine per horsepower is reduced.

c Where the lightness of reciprocating parts, like pistons, is of great moment, such as in high-speed gas engines, the use of aluminum is very beneficial. The aluminum piston also has the advantage of high heat conductivity, which is sometimes of greater importance in a gas engine than reduction in weight.

d For reducing unsprung weight in motor vehicles, aluminum is particularly valuable. This includes such parts as differential carriers, rear-axle housings, brake shoes, hub caps, wheels, etc.

e Aluminum alloys, especially with moderate pressures, function nicely as bearings against hardened steel. As an example, the Liberty Engine camshaft was run in aluminum bearings, as were also the rocker arms. Aluminum alloys, however, do not bear well against soft steel.

f For equal volumes aluminum is cheaper than brass or bronze. Aluminum alloys find extensive use as a substitute for brass and bronze castings where freedom from atmospheric corrosion is of prime importance and where the strength requirements are not too severe.

SELECTION OF ALLOY

For aluminum castings not highly stressed, No. 12 alloy should be used. Where freedom from leaks is the main requirement, the 12 per cent copper alloy is good and the more-ductile zinc alloy should be used for highly stressed parts. Present-day engineering materials are required to stand abuse rather than normal use. Ductility is essential if an alloy is to stand abuse, and this is the main reason for the use of the aluminum alloy containing 2.75 per cent copper, 1.5 per cent iron and 7 per cent zinc.

[The complete paper includes a brief discussion of the metalography of aluminum alloys, and of the aging of aluminum-alloy castings.—EDITOR.]

MALLEABLE CASTINGS

By ENRIQUE TOUCEDA[1], ALBANY, N. Y.

IN general, the selection of the proper kind of a ferrous casting for use in a given piece of construction is dependent upon a number of considerations, chief among which may be mentioned the following:

a Ability to successfully withstand the abuse to which it will be subjected in service

b High static and dynamic strength, which implies minimum sections for the strains involved, this in turn implying low cost for raw castings, as such are not only less costly in direct proportion to their strength, but their appearance is enhanced thereby

c Ease of machining, accompanied by a good surface on faced and turned parts, and freedom from unsoundness; which implies beauty of finished castings and low cost due to less loss from defective castings

d Smoothness of surface and trueness to pattern.

In discussing the foregoing a fact should be remembered that is frequently overlooked, viz., that the gray-iron, the malleable-iron and the steel casting have each a legitimate field of their own quite sharply defined by virtue of certain peculiarities possessed by each particular product. If a bedplate is desired for a certain large and ponderous machine, so dimensioned as to possess sufficient mass to enable it to absorb vibration, it would be unwise to specify that it be made of malleable cast iron. The malleable-iron founders are not at the present time equipped to cast and anneal castings of such size, and as cheapness and weight—obviously not high strength per square inch—are the dominant requirements in this case, the malleable-iron casting should not be specified. The same remarks hold good in the case of the steel casting, except of course that it is practical to make such castings as large as any made of gray iron.

GRAY-IRON CASTINGS VS. MALLEABLE-IRON CASTINGS

The truly legitimate field of gray iron, in the writer's opinion, should and will in time be restricted to the production of that size of casting that cannot successfully be produced in malleable iron and is too costly to produce in steel, while it is peculiarly well fitted for such castings as are designed to sustain static compression, for which purpose the gray-iron casting is without question superior to either of the other two. The average ultimate tensile strength of the gray-iron casting as measured by the test bar does not exceed 20,000 lb. per sq. in., while it possesses practically no ductility. The writer can state with positiveness that in the case of at least sixty of the malleable-iron foundries the average ultimate strength and elongation of their product, as measured by the standard test bar, are 51,000 lb. and 12.50 per cent, respectively.

It can safely be stated that if a gray-iron and a malleable-iron casting are designed to perform the same function, the design of each being based strictly upon its physical properties, in view of the great difference in their relative strengths, coupled with the fact that a larger safety factor must be used in the case of the former due to its inherent brittleness, the latter can safely be made more than one-third lighter. Inasmuch as this difference in weight will in large measure counterbalance the difference in cost per pound with the substitution of a ductile casting for one that is brittle and is actually more easy to machine, the writer believes that when this fact is fully understood and its significance appreciated, many castings now made of gray iron will be replaced by malleable, with the result that the gray-iron-casting field will of necessity be narrowed to this extent. It is therefore logical to conclude, as between these two products, that if the part can be successfully cast of malleable iron, the following statements hold true:

a For equal physical properties it is as cheap per raw casting

b It is as cheap per machined casting

c It will have a more pleasing appearance when assembled

d It will be lighter in weight

e Transportation charges will be less

f The weight per square foot on the floor will be less

g Breakage during transportation will be eliminated.

STEEL CASTINGS VS. MALLEABLE-IRON CASTINGS

If the same line of reasoning be used as between the malleable iron and the steel casting, it can be stated at the start, that neither can successfully trespass in certain directions in the field of the other, for each, as will be explained, has certain limitations that control the situation. There is hardly a limit to the size or weight in which the steel castings can be made, while as previously pointed out there is a limit in the case of malleable iron. On the other hand, there are castings that can be very nicely made of malleable iron that cannot well be made of steel, using the same pattern.

The American Society for Testing Materials standard specifications for steel castings deal with two classes: Class A, for which chemical but no physical requirements are specified and which need not be annealed unless so specified; and Class B, which is divided into three grades, hard, medium, and soft, it being specified that all of these grades shall be properly annealed, and also conform to certain chemical and physical requirements. While the ultimate strength of both Class A castings and the soft grade of Class B castings may average higher than that of malleable iron, their yield point will average lower by some 4000 lb. Consequently for equal stiffness the malleable-iron casting has an advantage in the case of equal sections.

Inasmuch as the A. S. T. M. specification for Class A castings states that they need not be annealed unless so specified, it is to be expected that the majority of these castings do not receive that treatment. This means the presence of internal strains in such castings, minimized to a certain extent, however, if baked molds are used. The writer knows of quite a number of large steel-casting companies that turn out a large daily tonnage of castings that are never annealed and assumes that in such cases they are made in accordance with specifications other than those of the A. S. T. M., and after considerable inquiry he has come to the conclusion that 70 per cent of the steel castings produced in this country are not annealed.

It happens that the heat treatment given the malleable-iron casting during the period in which the white iron is being converted into the malleable product, is carried on at a temperature just slightly in excess of the critical range, a temperature which yields practically the finest crystallization that the metal can attain, while the cooling from this temperature is effected at the rate of about ten degrees per hour. In consequence of this the malleable-iron casting is not only fine-grained but is invariably free from internal strains. On the other hand, not only are unannealed steel castings in a state of internal strain, but they possess a coarsely crystalline structure corresponding to the temperature of solidification. In view of all this, the writer believes that if a given casting be made of malleable iron it will stand more abuse in service than will a similar unannealed steel casting.

If the cost of the raw casting is the dominant factor, then unquestionably preference must be given to the malleable-iron casting, as the difference in cost is considerable. If based upon the cost of the finished casting, the difference between the cost of the two will be much greater, due to the greater ease with which the malleable casting can be machined, which difference will vary directly in proportion to the amount and character of the machining operations.

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[1] Consulting Engineer.

The malleable-iron casting is characteristically free from blowholes, while this is acknowledged to be one of the shortcomings of the steel casting; consequently, there will be less scrap in the case of the former. If rust-resisting properties are a consideration, as in the case of castings for refrigerator cars, the malleable-iron casting should be given preference over steel.

PROPERTIES AND LIMITATIONS OF MALLEABLE-IRON CASTINGS

In commercial practice the engineer who has placed his contract with a reliable foundry can depend upon a uniformity of product that will rarely have a yield point lower than 31,000 lb. per sq. in. and frequently as high as 33,000, an ultimate strength less than 50,000 lb., or an elongation less than 10 per cent. He can quite safely depend upon the integrity of the casting, for the reason that the founder has finally learned through costly experience that freedom from shrinkage depends not only upon correct gate emplacement, but more particularly upon the use of large shrink heads, so located as to eliminate such defects. Castings have been produced commercially as long as 5 ft., with sections at some parts as thick as 3 in. In regular practice castings varying in weight from 300 to 500 lb. are made daily, while it would be difficult to place a limit on how small they can be run.

The wearing properties of this metal correspond to what can be expected of wrought iron or dead soft steel, while as is well known its machining properties can hardly be excelled. As far as the ordinary uses of malleable cast iron are concerned, the writer feels quite certain that no beneficial results can follow from its heat treatment. In a limited number of cases, however, such as in the production of cheap hatchets, cleavers, and axes, malleable iron can be made file-hard by heating to just above the critical range and quenching.

COMPARATIVE COSTS OF GRAY-IRON, STEEL AND MALLEABLE-IRON CASTINGS

A general statement relative to the comparative cost of manufacture of the three products mentioned must obviously involve the consideration of many different cases and conditions. If it were not for the fact that in the case of the manufacture of malleable iron the annealing (which lasts from six to seven days and is a rather costly part of the process) must be taken into account, an approximate estimate could be made by figuring out the cost of the metal in the ladle for each of the three products; but the varying cost of molding in each case and the fact that the sprue can be easily knocked off from both gray and malleable-iron castings while it must be machined or cut off from the steel casting, render it rather difficult to make a comparison of the costs of the raw castings. In general, however, gray-iron castings run heavier than do those made of malleable iron. Consequently there is less sprue and therefore less remelt. Also there is less variation between the composition of the sprue and that of the charge and as a consequence a much larger percentage of scrap can be used in the mixture when making gray-iron than is possible in the case of the malleable castings. Assuming the highest fuel ratio in each case, 10 of iron to 1 of coke for the cupola, and 3 of iron to 1 of soft coal in the air furnace, it will be seen that the cost for fuel is less in the former than in the latter case. The same holds true in connection with furnace maintenance. Aside from cleaning and clipping, the gray-iron casting is finished when the metal fills the mold, while the white-iron castings must be cleaned, taken to the annealing room, packed in saggars, and then charged into the annealing oven and heat-treated for a period in most instances of seven days. The saggars must then be removed from the annealing oven, the castings again cleaned and sorted, to the cost of which must be added that of the fuel used for heat treatment, oven maintenance, supervision, and overhead. It can therefore be very easily seen that there must be considerable difference between the cost of production of these two products. The writer believes that on an average it will easily cost 1 cent a pound more to produce malleable-iron than it will the gray-iron castings, and at least 30 per cent more to produce steel castings than malleable.

STEEL CASTINGS

BY JOHN H. HALL,[1] HIGH BRIDGE, N. J.

THE more observing users of castings, having learned during the war that it is possible to produce a far better steel casting than had formerly been supplied, have in some cases profited by their recently acquired knowledge, and are demanding and securing the better product. The testimony of some of the very best makers of small steel castings, however, is to the effect that the buyers of their wares still adhere to their old practice of requiring first of all a freely machining casting and will not tolerate improvement in the quality of the steel if it interferes in the slightest with ease of machining. This attitude is unfortunate and really short-sighted, as in the long run it can have but one result. Those who maintain it are sure, sooner or later, to suffer from the competition of concerns making and machining their own castings, and willing to sacrifice a little to better quality. It is true at the present time that the very best steel castings made are used for the most part by those who make them, and for certain classes of product that are subjected to very severe service. Castings are now being made that show all-around physical properties nearly twice as good as those of the ordinary commercial steel casting, but the average machine-shop proprietor absolutely cannot be persuaded to use them, simply because they do not machine quite so freely as those he has been accustomed to in the past.

RANGE OF WEIGHT OF STEEL CASTINGS PRACTICALLY UNLIMITED

There are practically no limitations to the maximum and minimum weights of steel castings that can be produced commercially. The foundryman using a small bessemer converter, a crucible furnace or a small electric furnace can and does make castings with sections as light as 3/8 in., and in some cases even 1/4 in., provided their size and intricacy is not such as to make this impossible. On the other hand, the open-hearth furnace will pour castings as heavy as are ever called for, some poured in the last few years weighing 150 tons or even more, and with maximum sections of several feet. In fact, the steel foundryman is not so much concerned with the actual thickness of any particular section as with the combination of thick and thin sections in one and the same casting. When absolutely necessary, he can execute a casting of great intricacy in which thick and thin sections occur, often in exasperating combinations; but it is an undoubted fact that if the designer of castings would take counsel more often with the foundryman, he would obtain advice that would help him to secure a far better casting, and one that would more successfully meet the service it is called upon to stand.

PHYSICAL PROPERTIES OF STEEL CASTINGS

The physical properties of the average commercial steel casting depend largely upon whether or not the casting has been annealed. Perhaps 50 per cent of the steel castings made in this country are shipped without annealing. This statement is not made on actual knowledge and is consequently subject to criticism as too high or too low, depending upon whether the critic is or is not a steel foundryman. The American Society for Testing Materials specifications for steel castings call for two classes, A and B. Class A castings "need not be annealed unless so specified." The carbon of these castings is specified not over 0.30 per cent, and the phosphorus not over 0.06 per cent (at present 0.07 per cent is allowed). Such castings will test about as follows:

Tensile strength, lb. per sq. in.	60,000
Yield point, lb. per sq. in.	25,000
Elongation in 2 in., per cent	10 to 15
Reduction of area, per cent	15 to 25

The A. S. T. M. specifications do not call for tensile or bending tests on Class A castings. These specifications are intended to cover only such castings as are not subject to very severe service, and in which the chief characteristics desired are soundness and comparatively easy machining.

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[1] Taylor & Wharton Steel Co.

The writer is aware that some engineers are willing to accept unannealed steel castings for quite severe service, even for parts of locomotives and cars. The properties of the metal, as shown by the ordinary static tensile and bending tests, are considered good enough to justify the use of the unannealed steel. Of course the only steel so accepted is quite low in carbon, and accordingly fairly tough, at least in static tests.

From a fairly long acquaintance with cast steel, however, the writer is forced to state that in his opinion this policy cannot be justified. Our knowledge of endurance or "fatigue" tests teaches us that a coarsely crystallized metal such as unannealed cast steel cannot have a really high resistance to severe alternating stresses, and nothing like as high as the same metal will have after the coarse structure has been broken up by annealing and replaced by a finely crystalline condition.

It is when we come to consider resistance to sudden heavy shocks, however, that the danger of using unannealed cast steel for severe service strikes us most forcibly. Tests made by the writer have shown that under heavy shock cast steel even as low in carbon as 0.10 per cent breaks almost without bending, and with very little absorption of energy. In other words, the metal is truly brittle under impact test. After ordinary annealing the resistance to shock is greater, and the test piece bends through a greater angle before rupture. If the steel under test has been heat-treated by rapidly cooling and reheating, the shock resistance and angle of bend are increased to an even greater extent.

These tests were made on a Frémont testing machine; but the writer has made many tests on full-sized castings that amply justify him in his opinion that the use of unannealed cast steel for service calling for ability to resist sudden heavy shocks cannot be justified unless the sections of the piece can be made very heavy for the strength desired—in other words, unless weight per unit of strength can be disregarded.

The A. S. T. M. Class B castings must not exceed 0.05 per cent phosphorus or sulphur. (At present this has been temporarily increased to 0.06 per cent.) No other chemical specifications are given, the analysis other than phosphorus and sulphur being left to the judgment of the foundryman. Annealing, however, is specified. These castings are divided into three grades: Hard, Medium, and Soft, which must give physical properties as follows:

	Hard	Medium	Soft
Tensile strength, lb. per sq. in.	80,000	70,000	60,000
Yield point, lb. per sq. in. (=0.45 T. S.)	36,000	31,500	27,000
Elongation in 2 in., per cent	15	18	22
Reduction of area, per cent	20	25	30
Cold bend around 1-in. pin, deg	..	90	120

Reliable foundries can meet these specifications with practically no trouble beyond the expense necessarily due to meeting the requirement that castings be kept together by heats as poured, and the cost of making the test specimens and carrying out the tests. Most specifications as now written call for so many test pieces that the cost of producing the castings is considerably increased. This is particularly true when it is specified that a test shall be attached to each and every casting over a certain weight. The writer has known cases in which this specification was literally insisted upon where as many as fifty almost identical tests were pulled from a heat of open-hearth steel. The A. S. T. M. specifies a test attached to every casting weighing over 500 lb. unless the sections are such that a satisfactory test piece cannot be attached to it. In that case, and for castings under 500 lb., two test bars may be cast to represent a heat, or "in the case of small or unimportant castings, a test to destruction on three castings from a lot" may be used. This test shall show the material to be "ductile, free from injurious defects, and suitable for the purpose intended." This provision for testing small castings to destruction in place of using test bars is an excellent one and should be used more than it is.

Annealing and Heat Treatment

In order to meet specifications similar to those of the A. S. T. M., annealing is essential. The annealing practice followed is almost invariably such as to give the castings the greatest possible softness and ease of machining, and no heat treatment as the term is usually interpreted is needed to meet these specifications if the steel is well made in the first place. Castings annealed in this manner should machine very freely or fairly freely, depending upon whether they are of "soft" or "hard" grade, as prescribed. If the first cut is deep enough to get well under the scale left by annealing and if the casting is free from adhering sand, it should give no trouble in machining.

Heat treatment as usually understood, that is, annealing the castings at a proper temperature, cooling more or less rapidly, and then heating a second time, produces castings with very much better physical properties than those of plain annealed cast steel, and at the same time produces a somewhat harder and much-finer-grained steel which has far better wearing qualities and much better resistance to fatigue than is possible in the case of castings which are simply annealed. In extreme cases, by using heat treatment and special analysis, it is possible to produce castings that will show as good tensile strength as "Class B Hard" of the A. S. T. M. specifications, and equal or exceed the elongation, reduction of area and bend of "Class B Soft" castings. The yield point especially is raised by heat treatment, and the wearing properties are improved. The resistance to fatigue is also greatly iniucreased, and, most important of all, the power to resist sudden shock is enormously improved.

The cost of such heat treatment, if substituted for plain annealing when the castings are made, need not be higher than that of plain annealing, provided the foundry is properly equipped to carry out heat treatment. It must be confessed, however, that the average foundry today is not so equipped, and in many cases does not have on its staff a man who thoroughly understands heat treatment. In the writer's opinion this state of affairs is due as much to the buyer of castings as to the maker, because the buyer as a rule is not at all interested in the superiority of heat-treated or special-analysis steel castings, as soon as he finds that such castings machine a little less freely than the common variety. The writer has had violent protests from customers because some of his castings gave a long, curling chip in the lathe, as a forging does, instead of the usual crumbly chip of the common steel casting, and the fact that the physical properties of the castings were about as follows:

Tensile strength, lb. per sq. in.	85,000
Yield point, lb. per sq. in.	55,000
Elongation in 2 in., per cent	25
Reduction of area, per cent	50
Cold bend around 1-in. pin, deg	180

did not interest the customer in the least; and yet he had come to the foundry in which the writer was employed, and asked particularly for a casting to resist extremely severe fatigue and shock!

Cost of Steel Castings

The cost of steel castings, of course, varies with the size, weight and intricacy of the pattern to be executed. At the present time heavy castings such as are suitable for production in open-hearth foundries can be obtained for from 8 cents per lb. up, depending upon the difficulty of the job, while small and difficult castings command a price of about 12 cents per lb. up. No upper limit for price can very well be given, as very small or difficult castings, on which a piece price is often quoted, may go as high as $1.00 per lb. or even higher; but the foregoing figures are close enough for comparative purposes.

Where Steel Castings Should Be Specified

Steel castings should be used for all cases where a forging is not suitable or is prohibitive in cost, and where the service to be rendered calls for strength and toughness combined. To enumerate the uses of steel castings would be virtually impossible. It is enough to say that cast iron is suitable for service in which the stresses are chiefly compressive, or where the stresses to be endured can be taken care of by increasing the size of the casting, regardless of the resulting weight. In fact, in many cases where cast iron is used, as in bed plates of engines and heavy machines, great weight for a given strength is even desirable. Where moderate strength and toughness, combined with fairly good resistance to wear and fatigue, are desired, a malleable-iron casting is plenty good enough. When, however, the service demands all the strength, toughness, and resistance to wear and fatigue that are obtainable in a cast metal, a steel casting should be specified; and if the service is unusually severe, the engineer should use the best cast steel he can buy, and should not allow himself to be influenced in his choice by the fact that the metal does not machine as freely as inferior cast steel or malleable iron.

DIE CASTINGS

By CHARLES PACK,[1] BROOKLYN, N. Y.

DIE CASTINGS may be defined as castings made by forcing molten metal, under pressure into a metallic mold or die. It is erroneous to assume that all die castings have similar properties, since it is apparent that the properties of the die casting will depend upon the nature of the alloy used. The die-casting process is best adapted to alloys of comparative low fusing points which may, for convenience, be divided into the following groups:

Group A Zinc Alloys, consisting essentially of zinc alloyed with tin, copper or aluminum

Group B Tin Alloys, consisting essentially of tin alloyed with copper, lead or antimony

Group C Lead Alloys, consisting essentially of lead alloyed with tin or antimony

Group D Aluminum Alloys, consisting essentially of aluminum alloyed with copper.

No general rules can be laid down governing the design and application of die castings since the art depends largely upon the skill of the designers, and quite frequently a part may be considered as impractical from a die-casting standpoint which, if measured by given standards, may be redesigned and die-cast very successfully. Nevertheless the writer will endeavor to outline briefly the general properties of the alloys used, their fields of application and their limitations.

GROUP A—ZINC ALLOYS

Typical Alloy:

Zinc	87.5 per cent	Copper	4.0 per cent
Tin	8.0 per cent	Aluminum	0.5 per cent

Properties:

Color	Silver white
Weight per cu. in.	0.253 lb.
Melting point	780 deg. fahr.
Initial fusing point	275 deg. fahr.
Tensile strength	16,100 lb. per sq. in.
Elongation	2 per cent
Compressive strength	27,670 lbs.
Pressure required to shorten bar 1 in. diameter	10 per cent
Hardness number (Brinell)	64.6

Casting Limits:

Maximum weight for casting	8 lb.
Minimum limit of wall thickness	1/10 in.
Small castings	1/16 in.
Variations from drawing dimensions per inch of diameter or length	0.001 in.
Cast Threads, Minimum Number, External,	24 per inch
Internal	depends on conditions, often cast
Cast Holes; Minimum diameter	0.031 in.
Depending largely upon the depth and thickness of casting.	
Draft: Cores, 0.001 in. per inch of length or diameter.	
Side walls, 0.001 in. per inch of length.	

General Design. Sections of castings should be as uniform as possible. Sharp corners should be avoided and fillets added wherever permissible. Undercuts in castings should be avoided wherever possible.

General Remarks. Alloys of this type are corroded by any alkaline or aqueous solutions of any salts. Castings may be polished to a high luster, but soon tarnish when exposed to ordinary atmospheric conditions. Castings made from this alloy may be readily plated with nickel, copper, brass, silver or gold. When properly plated such castings will retain their luster as well as those made from brass or bronze.

Applications. Castings made from this alloy should not be used for parts that are subjected to severe stress or sudden shock in service. They are used extensively for parts of phonographs, calculating machines, drinking-cup, cigar, candy, stamp and gum vending machines, magneto housing, automobile-body trimmings, pencil-sharpening machines, time-recording devices, stamp-affixing machines, and for many other devices of a kindred nature.

GROUP B—TIN ALLOYS

Typical Alloys:

	Tin Per Cent	Copper Per Cent	Lead Per Cent	Antimony Per Cent
No. 1	90	4.5	0	5.5
No. 2	86	6	0	8
No. 3	84	7	0	9
No. 4	80	0	10	10
No. 5	61.5	3	25	10.5

Alloy No. 1 is a so-called "genuine babbitt" metal and was used very extensively during the war for main-shaft and connecting-rod bearings on all American-made aeroplanes and motor trucks. No. 2 is somewhat harder and is used extensively for bearings of internal-combustion engines. No. 3 is somewhat harder than alloy No. 2 and is the S. A. E. standard for high-grade internal-combustion-engine bearings. No. 4 is in general use for light bearings on stationary motors. No. 5 is a bearing metal for light duty and is used on a large number of moderate-priced automobiles for mainshaft and connecting-rod bearings.

In addition to the five compositions mentioned, hundreds of similar alloys may be made having various specific properties. A study of these alloys, however, would prolong this paper unduly, and in the opinion of the writer, is beyond its scope. The die-casting process, it may be said, is applicable to any of the alloys of this group and it may be left with the engineer to specify the alloy best suited to his requirements.

General Properties:

Maximum fusing point	450 deg. fahr.
Weight per cu in.	depends on lead content

Casting Limits:

Maximum weight for casting	10 lb.
Limit in wall thickness	1/32 in.
Variations from drawing dimension per inch of diameter or length	0.0005 in.
Cast Threads, minimum number:	
External	27 per inch
Internal	depends on conditions, often cast
Cast Holes: Minimum	0.031 in. diameter, depending on depth and thickness of casting
Draft: Cores, 0.0005 in. per inch of length and diameter.	
Side walls, 0.001 in. per inch of length.	

Applications. Tin alloys find their largest field of application in their use as bearings for internal-combustion engines. They are also used for parts of soda fountains, cream separators, milking machines, surgical apparatus, galvanometers parts, player pianos, etc., where a tensile strength of over 8000 lb. per sq. in. is not essential and where resistance to corrosion is of importance. They are not affected by water, weak acid or alkaline solutions, and when free from lead, are extensively used for food-container parts.

GROUP C—LEAD ALLOYS

Typical Alloys:

	Lead Per Cent	Tin Per Cent	Antimony Per Cent
No. 1	83	0	17
No. 2	90	0	10
No. 3	80	10	10
No. 4	80	5	15

Alloy No. 1 is generally known as C. T. (Coffin Trimming) metal, due to its extensive use in the manufacture of coffin trimmings. This alloy is also a good bearing metal for light duty and is used for thrust washers and camshaft bearings on light internal-combustion engines. No. 2 is somewhat softer and more ductile than No. 1. No. 3 is used extensively for light bearing duty, being somewhat tougher and stronger than Nos. 1 and 2. No. 4 is somewhat harder than No. 3 but less ductile. Many similar alloys may be compounded, all of which may be die-cast readily.

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[1] Doehler Die Casting Co.

General Properties:
Weight per cu. in.................. depends on lead content
Maximum fusing point.................. 600 deg. fahr.
Casting Limits:
Maximum weight for casting.................. 15 lb.
Minimum wall thickness.................. 1/32 in.
Variation from drawing dimensions per inch of diameter or length.................. 0.001 in.
Cast Threads, Minimum Number:
External.................. 24 per inch
Internal.................. depends on conditions, often cast
Cast Holes: Minimum diameter.................. 0.031 in. depending on depth and thickness of casting
Draft: Cores, 0.0005 in. per inch of length and diameter
Side walls, 0.001 in per inch.

Applications. Lead alloys may be used where a metal of non-corrosive properties is desired and where a tensile strength of not over 8000 lb. per sq. in. will suffice. They are used extensively for fire-extinguisher parts, low-pressure bearings, ornamental metalware, and many parts that come in contact with corrosive chemicals. They should not be used for parts that may come in contact with foods or that may be handled often in service, since the poisonous properties of lead and lead alloys are well known.

The main advantage of these alloys lies in their comparatively low cost, but their high specific gravity must be considered, some lead alloys having a specific gravity double that of the zinc alloys.

During the war lead alloys were used for all hand-grenade fuse parts and many millions of these parts were made. Lead-alloy die castings were also used for thermite grenades, offensive grenades, trench-mortar fuse plugs and many other parts where a non-corrosiveness was an essential requirement.

GROUP D—ALUMINUM ALLOYS

Typical Alloy:
Aluminum, 92 per cent; Copper, 8 per cent.
Properties:
Color.................. silver white
Weight per cu. in.................. 0.115 lb.
Melting point.................. 1150 deg. fahr.
Tensile strength.................. 21,000 lb. per sq. in.
Elongation.................. 1.5 per cent
Hardness number (Brinell).................. 60.5
Casting Limits:
Maximum weight for castings.................. 5 lb.
Minimum wall thickness.................. 1/16 in.
Variation from drawing dimensions per inch of diameter or length.................. 0.0025 in.
Cast Threads, External: Minimum number...... 20 per inch
Threads are cast oversize 0.01 in. to be chased to size. Internal threads rarely cast.
Cast Holes: Minimum diameter 0.093 in. and not deeper than 1 in. Larger cores may be cast much deeper; smaller holes may be spotted to facilitate drilling
Draft: Cores, 0.015 in. per inch of diameter or length. Side walls, 0.005 in.
Cores of less than ¼ in. diameter to have 0.005 in. draft per in of length and diameter.

The composition described above is well known in the arts as No. 12 alloy and is used very extensively for automobile and aeroplane parts. By varying the copper content harder or softer alloys may be obtained, all of which may be die-cast successfully.

Applications. Aluminum die castings find wide employment in the manufacture of parts of automobiles, such as spark and throttle control sets, magneto parts, battery ignition and lighting systems, speedometers, etc. They are also used for parts of vacuum sweepers, phonographs, milking machines, vending machines, etc.

BRASS AND BRONZE DIE CASTINGS

Die castings made from various types of brasses and bronzes were put on the market as early as 1910, but have never been successful commercially. At the present time there is only one die-casting manufacturer producing brass die castings in any appreciable quantity.

It is a comparatively simple matter to produce a small quantity of sample brass die castings, but no material has yet been found for die-making purposes, which will withstand the continuous action of molten brass and at the same time retain its shape, surface and size. The die casting of brass and bronze must be considered as in the experimental stage at the present time, with little or no immediate prospect of the solution of the problem.

DEVELOPMENTS DUE TO THE WAR

The most important development in the art of die casting during the war was the perfection of the process of die casting aluminum and its alloys. A suitable steel was developed for making the dies for this process that would withstand the action of molten aluminum without cracking, a problem the solution of which was essential to the development of the industry.

The part that this development played in the winning of the war will be readily appreciated when it is stated that at the cessation of hostilities there were being produced about one million aluminum die castings daily in this country for parts of gas masks, machine guns, aeroplanes, motor trucks, motor ambulances, surgical instruments, canteens, field binoculars, and many other appliances of war.

COMPARATIVE COST OF DIE CASTINGS

The cost of die castings cannot be computed on the pound basis since it depends on the design of the piece, the number and position of the cores, the quantity to be produced and certain other factors. For comparative purposes it may be stated that at the present time tin-alloy castings are the highest in cost, being followed by those of aluminum alloy, zinc alloy and lead alloy in the order named.

In considering the use of die castings it is well to bear in mind that on a pound basis die castings are far more expensive than iron sand castings where the machining cost is not considered. As the zinc alloys, whose properties are similar to cast iron, cost from $200 to $275 per ton in ingot form, it is apparent that the substitution of a die casting for an iron casting can only be considered when the machining cost is sufficient to compensate for the difference in cost of the raw materials.

BRASS AND BRONZE CASTINGS

By CHRISTOPHER H. BIERBAUM,[1] BUFFALO, N. Y.

THE terms "brass" and "bronze" are not as definite in their meaning as might be desired. The term bronze was formerly applied to an alloy of copper and zinc. Usage, however, has changed and it is now generally applied to an alloy of copper and tin, while the term brass is used to denote an alloy of copper and zinc. This change of nomenclature has led to a great deal of confusion. Even today we speak of crankpin, crosshead, or engine brasses when we have bronzes in mind; that is, a copper-tin alloy with comparatively little, if any, zinc in its composition. In general, it may now be said that without a modifying adjective brass is an alloy of copper containing a large amount of zinc; and bronze is an alloy of copper containing a relatively large amount of tin. In this country no general standard of terminology for these alloys has as yet been adopted; the British Institute of Metals has adopted one, but theirs does not seem entirely satisfactory for our purpose. For the present, in this discussion, these alloys will be designated according to the prevailing commercial usage in this country; and other alloys will, as far as possible, be designated in the order of their preponderant constituents. Thus, the copper-tin-lead alloy is one containing, by weight, more copper than tin, and more tin than lead.

It is very generally understood that in designing machine parts which are to be made of cast materials a larger factor of safety is necessary than that required for rolled or forged material, although the compositions may be very similar or even identical. This in itself is not sufficient. The fact that the strength in any given casting varies in its different parts must also be taken into consideration, since it is impossible to make a casting with varying sections of uniform strength.

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PRECAUTIONS TO BE TAKEN IN SPECIFYING BRASS AND BRONZE CASTINGS

In general, the engineer should be cautioned against specifying alloys upon which he has only such knowledge as has been derived from laboratory tests alone, since it is impossible to determine, by ordinary experiment, all of the economic conditions which enter into the founding and tooling of a casting and the requirements of a subsequent satisfactory use of an alloy for any given service. To illustrate: Years ago the favorite Government composition known as gun metal (88 per cent copper, 10 tin and 2 zinc) was unreservedly specified for valves, steam connections and fittings. At the present time, however, no successful valve manufacturer would think of using this alloy for this purpose, although, from purely laboratory results this and similar high-tin alloys may appear to meet the requirements. The safe procedure is either to investigate and follow standard practice, or determine definitely why it should not be followed; or else to leave the composition and the guarantee of results to a responsible manufacturer and hold him accountable.

Aluminum should never be used in an alloy which is to be tight against leakage of either a gaseous or fluid substance. Aluminum has the peculiar property of forming a characteristic skin upon the surface of its alloys, due to its great affinity for oxygen. Appreciably less than one two-hundredth of one per cent of aluminum produces an appearance upon the surface which is very distinctly that of a brass or bronze casting. In fact, this surface film is often found in castings where the amount of aluminum present is so small that the chemist may be in doubt as to whether even a trace of it exists. In pouring a casting containing aluminum this surface film becomes entrained in the convecting currents as the molten metal fills the mold and often extends through the entire thickness of the wall of the metal and thus gives rise to porosity which causes leakage. For the foregoing reasons it is always desirable, when pouring, that the molds should fill with as little bubbling and splashing as possible. This applies to all alloys in general, but to those containing aluminum in particular. The "horn gate" or some form by means of which the molten metal enters at the lowest point in the mold is very desirable.

In the alloying of copper and tin a low-fusing crystal forms known as the tin-copper eutectoid. This crystal is hard and brittle and in general should not be present in bronzes used for machine parts; and more particularly so if these parts are subjected to temperatures approaching that of high-pressure steam. This crystal always forms in ordinary foundry practice when tin is present in amount equal to 9 per cent of the copper content. In slow cooling the amount of this crystal is increased and slow cooling also causes it to appear with a lower percentage of tin. High-tin bronzes should neither be used under high temperature nor where they are subjected to severe shock. Without doubt this eutectoid crystal constitutes the most valuable bearing crystal for bearing metals to be found in any of the bronzes.

Considerable experimental work has been done at different times and in different laboratories on the subject of heat treatment of foundry bronzes and brasses which are to be used without subsequent forging or tooling. These experiments have been applied particularly to the copper-aluminum alloys and to the copper-tin alloy known as gun metal. Nothing, however, has as yet developed to bring this process of heat treatment into general commercial importance.

Brass-foundry products do not compete directly with cast iron, cast steel or steel forgings in machine construction. They are specified by the designer only when certain properties are necessary, such as appearance, bearing value, chemical composition, and the like. These non-ferrous products never can compete directly in cost with the ferrous products for the reasons that copper is always higher-priced than iron and the price of tin is always subject to foreign speculation; while few of the minor constituents compare favorably in price with iron.

BRONZES

Manganese Bronze is the term generally applied to a composition which, properly speaking, is a brass instead of a bronze. It is an alloy of copper containing a high percentage of zinc, aluminum and iron, in which a small amount of manganese has been used. The beneficial effects in this alloy due to the deoxidizing and iron-carrying properties of the manganese are very striking. Beneficial results are obtained even though no more than a mere trace of manganese finally remains in the resulting product. In none of the brass-foundry products are the high merits of an alloy so much due to the results of skilful and intelligent foundry practice as in the case of this particular alloy. The composition is relatively cheap when the cost of its constituents is considered.

The cost of the final product, however, is much higher than its composition would indicate, due to the following requirements necessary for the production of satisfactory castings: The introduction of a small percentage of iron is necessary for proper results, and care and skill with proper equipment are indispensable for this operation; secondly, the amount of metal required for gates, heads and risers necessary for this alloy is unusually large, so much so that in the production of ordinary automobile castings only from 17 to 39 per cent of the entire metal melted finally appears in the form of finished castings; and lastly, the loss in melting is unusually large. For machine construction this alloy, of all brass-foundry products, is of first importance. In strength it successfully competes with steel castings and steel drop forgings although the price is from three to five times that of malleable castings. This, and its non-corroding properties make it a most desirable material in automobile and marine construction. As a foundry product it is a very desirable material as it has a very smooth surface. The labor for finishing it is in many cases so light compared with that required for finishing steel castings that it can often compete with steel castings. This is especially true in automobile construction. It has the necessary strength for brackets, standards and fixtures, so that it can replace both steel castings and forgings for these purposes. Manganese bronze has a field of usefulness in experimental work in that it can be produced with less delay than steel forgings, stampings or malleable castings, requiring as it does so little finishing. By varying the two principal constituents of manganese bronze the desired physical characteristics can be obtained. An increase of the percentage of copper increases its elongation, whereas an increase in zinc increases its ultimate tensile strength but decreases its elongation. When this material is made up with the necessary precautions as to purity and foundry methods, very excellent commercial results can be obtained. For example, a tensile strength of 90,000 lb. per sq. in. with 30 per cent elongation can be secured in a standard test coupon, whereas many producers consider 65,000 lb. tensile strength with 15 per cent elongation as fair.

Aluminum Bronze is an alloy of copper and aluminum containing from 4 to 11 per cent of aluminum and the remainder copper. In recent years, however, this alloy has been made up with an addition of from 1 to 6 per cent of iron. The introduction of iron produces twofold results: First, it causes the alloy to solidify with smaller crystals, that it, it produces a finer grain; and secondly, it adds a third hard crystal formed by the union of aluminum and iron which is much harder than the other two crystals. This is the only brass-foundry product which can compete commercially with manganese bronze. With care it can be so made up as to have a somewhat higher ultimate strength than manganese bronze, although it does not possess a higher yield point or elastic limit. The drawback to this alloy is the inherent difficulty of making solid castings. The tendency to have blowholes is very characteristic, and even extreme skill will overcome this difficulty only in a degree. Aluminum bronze may be used for bearing purposes, and recently, when containing iron, has had a limited use for motor-truck worm drives. The only advantage of this latter alloy over a copper-tin-bronze composition is its cheapness; for bearing purposes, however, it cannot compare with a copper-tin alloy.

Acid-Resisting Bronzes. These are some of the brass-foundry products which formerly were of more importance than they are today, owing to the fact that stoneware and specially modified cast iron are now largely replacing these uses. There are, however, some uses for bronzes to resist sulphuric and sulphurous acids in mine service, pulp mills, and other industries. For these purposes two alloys are most serviceable; a copper-tin-lead alloy containing substantially 86 per cent copper, 12 per cent tin and 2 per cent lead; and aluminum bronzes containing a small iron percentage.

Copper-Tin Alloys. First among these alloys highest in its tin content may be mentioned bell metal, a composition containing from 16 to 25 per cent of tin. As the name implies, it is used for the manufacture of bells, gongs, steam whistles and the like. It is a resonant metal. For industrial purposes the compositions used are those having the lower percentages of tin, say from 16 to 18 per cent. The higher percentages of tin, especially between 20 and 25 per cent, are used for bells in which high tone quality is required. The production of these bells requires considerable skill and constitutes a special industry. In general, however, it may be said that for all purposes the constituents for these alloys should be extremely pure and every precaution against oxidation should be taken during melting and pouring, since the quality of the product is altogether dependent upon the purity of the alloy.

The next alloy of this type to be considered is a bronze used in turntables and movable bridges. This composition is given in the tentative A.S.T.M. specification as "Class A, Bronze Bearing Metals for Turntables and Movable Bridges." It is also given as "Grade A" in the American Railway Engineering Association specification bulletin of July, 1918. It contains 20 per cent of tin, and phosphorus not to exceed 1 per cent. It is very hard, due both to its tin and its phosphorus contents. For best service conditions it should not be used except when placed between hardened steel plates. It is intended for pressures over 1500 lb. per sq. in. and slow-moving bearings.

A composition similar to the foregoing is one given as "Class B Bronze" under both of the immediately foregoing specifications and containing 17 per cent of tin with a permissible phosphorus content of 1 per cent. It does not seem wise to permit this amount of phosphorus in a bearing metal of this kind, however, if to be used as specified between "soft steel plates." Better service conditions can be obtained by the production of the necessary hardness through increase of tin content and reduction of phosphorus. An alloy containing 19 to 20 per cent tin and only a trace of phosphorus would give better service when used on soft steel. In a case of this kind where a copper-tin bronze is used between unhardened steel surfaces the amount of phosphorus present should be very limited owing to the exceeding hardness of the copper phosphide crystals.

The next alloy of importance as to its tin content is a bronze containing 11 per cent of tin and a maximum of 0.2 per cent of phosphorus. This alloy is the standard composition now in very general use for worm wheels in motor-truck drives and in the motor-car reduction worm gears. A feature of considerable importance in the making of this alloy seems to be that of producing the proper amount of chilling effect in the cooling of the castings. In some cases zinc has been added to an amount of 2¼ per cent; results show, however, that the addition of zinc is undesirable although it produces an additional hardness of the alloy as indicated by the Brinell and scleroscope tests. This additional hardness rather detracts from its bearing value, and, at the same time, makes it more difficult for tooling. It seems self-evident that the above alloy, as it now stands, could be improved by the addition of a small amount of lead,—not sufficient to produce undue weakening,—and that this would result in a threefold benefit: easier tooling, increased accuracy of tooled surfaces, and a higher bearing value.

Copper-Tin-Zinc Alloys. The most popular alloy of this class is the one known as ordnance bronze or gun metal. Its composition is 88 copper, 10 tin and 2 zinc. This alloy has come to be a very generally known composition in that it is a general-average bronze. However, with a more complete metallurgical knowledge of the relative values of different compositions, it becomes of less importance, in that it is specifically neither a bearing bronze of high merit nor a bronze especially adapted for machine parts when maximum economy of alloy is considered. The high tin content produces in this alloy a high percentage of the tin-copper eutectoid, with the resulting disadvantages when the alloy is used for other than bearing purposes. The use of ordnance bronze for the construction of machine parts is, for two reasons, a wasteful one: It contains an unnecessary amount of tin, a high-priced constituent, and more serviceable alloys can be produced by the use of a lower percentage of tin. For machine parts, steam connections and valves, a composition having, say, 90 per cent copper, 6½ tin, 2 zinc and 1½ lead is a superior alloy for the reasons that it can be produced as a more economic foundry product, its price is less, its physical properties are superior, and lastly, its machining qualities are superior. On the other hand, the zinc in ordnance bronze distinctly detracts from its bearing value.

Copper-Tin-Lead Alloys. These alloys are strictly bearing compositions containing not in excess of 82 per cent of copper and a tin maximum of 11 per cent with a lead maximum also of 11 per cent. This range of alloy corresponds to "Class C" of the A.S.T.M. tentative specifications for Bronze Bearing Metals for Turntable and Movable Railway Bridges. These alloys are usually deoxidized with phosphorus which has a tendency to suspend or diffuse the lead, since in all these alloys the lead is held in mechanical suspension without any chemical union. The most generally used of this series contains 80 per cent copper, 10 tin and 10 lead.

To enumerate all of the copper-tin-lead alloys given by various authorities as bearing bronzes would constitute an almost infinite series. The whole matter, however, can be summed up in a few words: Lead is a desirable constituent in a bearing alloy but has the drawback of weakening the bronzes, therefore, for light service, or under conditions where a supporting oil film cannot always be maintained, as in car or truck bearings, the compositions containing the higher proportions of lead should be used. Where the punishment is severe the alloys should have a lower percentage of lead. As a rule it is economy to use as much lead as possible, since lead is a cheaper metal and it also adds materially to the bearing value of the alloy.

Copper-Lead-Tin-Zinc Alloys are those containing from 3 to 12 per cent of lead, from 4 to 6 per cent of tin and from 1 to 10 per cent of zinc. This series of compositions includes several used for bearing purposes, especially those having the high lead limits. The addition of zinc in this alloy is for the purpose of reducing the cost; it does not add to the value of the alloy except in its physical strength and it detracts from its bearing value. The series includes the popular red-brass composition; 85 per cent copper, 5 tin and 5 zinc; and also a cheaper composition containing 77 per cent copper, 10 lead, 3 tin and 10 zinc used for low-pressure valves and plumbers' supplies.

GRAY-IRON CASTINGS

By RICHARD MOLDENKE,[1] WATCHUNG, N. J.

In working out problems in machine design the mechanical engineer is constantly confronted with requirements for those parts he wishes to make of cast iron, which makes it necessary for him to be fully informed in regard to the latest developments in the foundry industry. Where to use a casting and what metal or alloy to make it from should be pretty well known by now, but what class of cast iron to use and what kind of a foundry to get it from may be matters open to doubt in these days of rapid changes. Therefore, even though he depends upon the foundryman to deliver him the kind of casting he needs, the engineer should have some knowledge of the underlying causes for the peculiar properties exhibited by cast iron when put into the form of castings.

THE CARBON SITUATION IN CAST IRON

To understand the nature of the complex material known as cast iron it is necessary to go behind the returns of an "ultimate analysis," as it were, in order to get the "rational" analysis, or the grouping up of the several elemental constituents. Here it will be seen that the total carbon is present in two forms, part of it being a mechanically mixed crystalline graphite and the remainder being chemically combined. The amount, distribution and physical condition of the graphite thrown out of solution at the moment of set are the more particular items of importance to the engineer in connection with the strength and machinability of the casting. While the total carbon of the metal is the same throughout the mass, the division into mechanically mixed graphite and combined carbon will be such that the highest proportion of the former will be found in the center of the section, together with the least of the latter form, and vice versa. Since the presence of combined carbon in increasing proportion means corresponding increase in hardness, the metal at the surface of a casting will be harder than in the center. Further, the oxide of iron formed through contact of molten iron with a damp mold surface and the fluxes in the molding sand, if not properly covered with adhering graphite, on interacting form an enamel which is very hard on the cutting tool, and hence this should be made to dig under the skin of the casting and lift the surface metal away as it cuts along under lubrication of the graphite present and not be allowed to glide over the skin.

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With the foregoing explanation of the carbon situation in cast iron, and remembering that graphite is in mechanical admixture only, and consequently is an element of weakness by cutting up the continuity of the iron mass, it will be understood that fundamentally cast iron is a steel of given combined carbon content, with the other elements present in much higher percentages than one would expect in any steel. For instance, if the percentage analysis of the chips taken from the first eighth inch below the surface of a flat plate gave silicon 2.00, manganese 0.70, phosphorus 0.45 and sulphur 0.12; with graphite 3.20 and combined carbon 0.30; then that part of the plate was for practical purposes a 30 carbon steel containing much graphite, double the usual sulphur and ten times as much phosphorus as a steel ought ordinarily to contain. The fact that the proportions of the two forms of carbon vary from surface to center conclusively shows that while the total carbon of a cast iron analysis may be perfectly reliable, the items "graphite" and "combined carbon" in such an analysis are worthless unless the actual point from which the sample has been taken is indicated.

Silicon as the chief determining factor of the condition of the carbon present may run from as low as 0.35 per cent in deeply chilled castings up to 3.25 per cent in the very lightest of hardware and novelty work. The absence of silicon allows the carbon to remain in chemical combination with the iron. As the percentage of silicon increases the iron loses its power to hold the carbon in combination and it is thrown out as graphite at the moment of set. The higher the silicon the greater the graphite percentage. A factor affecting the silicon content to be employed is the rate of cooling of the metal when a mold is filled with molten iron. The thinner the section the greater the power of the iron to hold the carbon in chemical combination in spite of the silicon present. Hence high silicon is necessary to prevent thin sections from turning out hard, and since the foundryman must deliver his casting in condition to machine properly, he naturally regulates the silicon of his mixture to care for the thinest section. If he were to aim for strong iron with a reasonable machinability for the heavier sections of the casting to be made, making his mixtures accordingly with high-steel-scrap percentages and comparatively low silicon, the thin ribs and brackets of the casting would come out hard and brittle, if not actually white in fracture, and the greater contraction of these in cooling from the molten state would cause bad warping and internal strains. The mechanical engineer should therefore study the metallurgical side of the foundry requirements so that he may design his work with the least abrupt changes in section, avoid sharp corners and distribute his metal to the best advantage—in other words, give the casting a chance.

The total-carbon percentage has come to be a most important factor in the iron-castings industry. Of recent years the comparatively low-total-carbon iron made in the air furnace, and called "gun iron" from its use previous to the days of the steel cannon, has been paralleled by cupola metal in which great quantities of steel scrap are added to the mixture. Even in the air furance, the former long periods of refining to reduce the total carbon are shortened by adding all the way up to 30 per cent of steel scrap to the mixture of pig irons and home scrap. The product gets the erroneous name of "semi-steel" from those who are not informed on the properties of this grade of cast iron—for it is only a high-grade cast iron, with none of the properties of steel. Its importance to the engineer lies in the fact that the reduction in total carbon through steel additions can be carried to a point where the ultimate strength is nearly doubled and where the chips taken from such a casting curl up almost as well as those from hard steel, for which reasons it serves very well where it is not essential that steel be used. The foundryman, however, has a problem before him in running these high steel-scrap heats. Only the best of cupola and mold-gating practice will yield castings free from blowholes, cracks and serious internal shrinkages. The silicon percentage must be watched particularly, so that separation of graphite and combined carbon may leave the latter low enough for proper machinability. The effect of low total carbon (it may be brought down to 2.25 per cent, or just above the line of division into steel), if the combined carbon is kept normal, is to give an otherwise lower graphite percentage. Necessarily this graphite is finer in crystallization, and there being less of it than normal, the planes of separation in the solid metal are smaller and fewer, hence the greater strength. Moreover, there is much less phosphorus present as the result of the low phosphorus of the steel added.

Manganese in the castings should not be allowed to run below 0.50 per cent and not over 1.00 per cent for normal machinable work. Phosphorus should be as low as possible, considering the pig irons that must be used, and for important and thick work had better run below 0.40 per cent. Very thin castings, such as art and architectural details in structures, which really correspond to the "stove plate" of the foundryman, require very nearly 1.00 per cent of phosphorus to come out in perfect detail. Table 1 gives recommended compositions of castings for many purposes. It is not wise for the engineer to specify the chemical composition of the castings he requires, but if strength is important it should be specified according to the standards of the American Society for Testing Materials.

SPECIALIZATION IN IRON FOUNDING

The foundry industry is pretty well divided up into specialized lines of work. If the engineer needs chilled castings he turns to the makers of chilled rolls. Many foundries, however, other than roll makers produce crusher castings, balls for grinding, shoes and dies for stamp mills. Another important branch of foundry work is the making of cylinders. For the highest grade, foundries having air furnaces should be selected, particularly if they make a specialty of cylinders, piston rings and the like; and they will be found among the great foundry and machine works of the country building heavy machinery and engines, particularly of the marine type. Castings to withstand high pressures, such as those of air, steam and ammonia, are made by foundries specializing in air compressors, pumps, refrigeration machinery, and the general valve and fitting trade. For light parts to serve for ornamental purposes there are many stove shops to which recourse may be had. In general, however, where reciprocating parts or sections of intricate character and for severe service strains are required, it is safer to go to the large concerns making well and favorably known lines of product. The foundries connected with such establishments have the proper facilities and the trained men to undertake the work, and will be in position to advise improvements in design to give the metal a better chance for the purpose intended. Foundries of the class just mentioned usually have need of several mixtures of iron to supply the parts required for the line of machinery turned out. Hence, they usually run a few charges of fairly low silicon, high steel scrap-metal for such castings as air-compressor cylinders, rolling mill parts, and other work of high strength and density. The next charges may then care for ordinary machinery castings, and finally a few extra soft or high-silicon charges may care for pulleys and the very light-section product. Sometimes the process is reversed, all light, soft work being run first and the harder classes at the end of the heat.

TABLE 1 RECOMMENDED ANALYSES FOR VARIOUS CLASSES OF CASTINGS

Castings	Light					Medium					Heavy				
	Si	Mn	S	P	T.C.	Si	Mn	S	P	T.C.	Si	Mn	S	P	T.C.
Acid-resisting	2.00	0.75	0.05*	0.20*	3.25*	1.50	1.25	0.05*	0.20*	3.25*	1.00	1.25	0.05*	0.20*	3.25*
Agricultural	2.50	0.60	0.06	0.75	3.75	2.25	0.70	0.08	0.70	3.50	2.00	0.80	0.10	0.60	3.25
Air Cylinders	1.90	0.70	0.08	0.50	3.40	1.50	0.80	0.09	0.40	3.25	1.00	0.90	0.10	0.30	3.00
Annealing Boxes	......	......	......	......	......	0.65	0.20	0.08	0.20	3.50	......	......	......	......	......
Automobile Cylinders	2.25	0.65	0.08*	0.40*	3.25*	2.00	0.75	0.08*	0.40*	3.25*	......	......	......	......	......
Balls for Grinding	......	......	......	......	......	0.75	0.50†	0.15*	0.40*	3.75†	0.50	0.50†	0.15*	0.40*	3.75†
Bedplates	2.00	0.70	0.08	0.60	3.75	1.75	0.75	0.10	0.50	3.50	1.50	0.80	0.12	0.40	3.25
Boiler Castings	......	......	......	......	......	2.00	0.80	0.06*	0.20*	3.50*	......	......	......	......	......
Car Wheels	......	......	......	......	......	......	......	......	......	......	0.65	0.50	0.08	0.35	3.50
Chilled Castings	......	......	......	......	......	......	......	......	......	......	......	1.00	0.06*	0.20*	3.50*
Chills	......	......	......	......	......	1.00	0.50	0.05	0.20	3.00	......	......	......	......	......
Crusher Jaws	......	......	......	......	......	1.00	1.00	0.04	0.20	3.50	0.80	1.25	0.06	0.20	3.25
Dies for Hammers	......	......	......	......	......	1.50	0.60	0.05	0.20	3.00	1.25	0.80	0.06	0.20	2.75
Dynamo Castings	2.50	0.50	0.05	0.75	3.75	......	......	......	......	......	2.15	0.50	0.06	0.50	3.25
Electrical Work	3.00	0.50	0.03	0.60	3.75	2.75	0.50	0.05	0.50	3.50	......	......	......	......	......
Engine Frames	......	......	......	......	......	2.00	0.60	0.08	0.50	3.50	1.75	1.00	0.10	0.40	3.00
Fire Pots, Grates	2.25	0.60	0.05	0.20	3.50	2.00	0.80	0.06	0.20	3.25	......	......	......	......	......
Fly Wheels	2.00	0.50	0.05	0.50	3.50	1.50	0.60	0.06	0.40	3.25	1.25	0.70	0.08	0.30	3.25
Friction Clutches	2.40	0.60	0.10	0.70	3.75	2.00	0.70	0.12	0.50	3.50	......	......	......	......	......
Furnace Castings	2.40	0.60	0.05	0.60	3.75	2.15	0.80	0.06	0.50	3.50	......	......	......	......	......
Gas-Engine Cylinders	2.00	0.70	0.08	0.40	3.25	1.50	0.80	0.09	0.30	3.00	1.25	0.90	0.10	0.20	2.85
Gears	2.25	0.60	0.08	0.70	3.75	2.00	0.80	0.09	0.60	3.50	1.50	1.00	0.10	0.50	3.25
Glass Molds, Pipe Balls	......	......	......	......	......	2.50	0.60	0.04	0.20	3.25	......	......	......	......	......
Grate Bars	......	......	......	......	......	2.00	0.60	0.05	0.20	3.50	......	......	......	......	......
Gun Iron	......	......	......	......	......	1.50	0.50	0.05	0.30	3.25	1.00	0.60	0.05	0.30	3.00
Hardware	2.50	0.70	0.08	0.80	3.75	......	......	......	......	......	......	......	......	......	......
Heat-resistant Iron	......	......	......	......	......	2.00	0.80	0.06	0.20	3.25	1.50	1.00	0.06	0.20	3.00
Hydraulic Cylinders	......	......	......	......	......	1.50	0.80	0.05	0.40	3.25	1.00	1.00	0.08	0.20	2.85
Ingot Molds	......	......	......	......	......	......	......	......	......	......	1.25	0.80	0.06	0.20	3.75
Machinery Castings	2.50	0.60	0.08	0.70	3.75	2.00	0.80	0.09	0.60	3.50	1.50	1.00	0.10	0.50	3.25
Mine Wheels	......	......	......	......	......	0.90	1.00	0.10	0.20	3.00	......	......	......	......	......
Ornamental Castings	2.75	0.60	0.06	0.90	3.75	2.25	0.70	0.08	0.80	3.50	......	......	......	......	......
Pipe (Water)	2.25	0.60	0.06	0.80	3.75	2.00	0.80	0.08	0.70	3.50	1.50	1.00	0.10	0.60	3.50
Piston Rings	2.00	0.70	0.05	0.60	3.50	1.75	0.80	0.06	0.50	3.25	......	......	......	......	......
Pulleys	2.40	0.50	0.05	0.70	3.75	2.15	0.60	0.07	0.60	3.50	1.90	0.70	0.09	0.50	3.25
Radiators	2.25	0.70	0.06	0.80	3.50	......	......	......	......	......	......	......	......	......	......
Rolls (Chilled)	......	......	......	......	......	......	0.80	0.06	0.40	3.25	......	1.00	0.08	0.30	3.00
Soft Castings	2.60	0.50	0.06	0.60	3.75	2.40	0.60	0.08	0.50	3.50	......	......	......	......	......
Soil Pipe	2.25	0.60	0.08	0.80	3.75	2.00	0.80	0.10	0.60	3.50	......	......	......	......	......
Steam Cylinders	2.00	0.60	0.08	0.50	3.50	1.60	0.80	0.09	0.40	3.50	1.25	1.00	0.10	0.30	3.50
Stove Plate	2.50	0.50	0.06	1.00	3.75	2.25	0.60	0.08	0.80	3.50	......	......	......	......	......
Valves	2.25	0.60	0.07	0.50	3.25	1.75	0.80	0.08	0.40	3.00	1.25	1.00	0.09	0.30	2.85
White Iron Castings	......	......	......	......	......	0.75*	0.20†	0.25*	0.75*	2.50†	......	......	......	......	......

*Below. †Above.

Recent Tendencies in Gray-Iron Foundry Practice

The passing of the war has given us time to realize more fully the train of evils that have been its legacy to the foundry. While there was a tremendous expansion of other industries due to war demands, the foundries simply pushed production to the utmost consistent with ability to get raw materials and men. Impossible prices for pig iron resulted in the use of so high a proportion of scrap in the mixtures that when the castings made during this period of stress eventually land into the scrap piles of the country—probably within the next twenty years—a serious problem of very high sulphur and oxidized iron will confront the foundryman. Instances of 90 per cent scrap in the mixture were common and castings with over 0.20 per cent sulphur equally so.

The problem will have to be faced, and there are two possible solutions. The method heretofore employed in such a case is the increased use of pig iron in the mixtures. Before the war the common practice was to use not over 40 per cent scrap with 60 per cent pig. Now it is reversed. Consequently, instead of having the sulphur run about 0.08 per cent maximum in important work, it is more nearly 0.12 per cent. Ordinary work today touches 0.18 per cent without much comment. It is true that even a higher sulphur content will not militate against machinability provided the melting practice is of the very best, but the castings are more subject to danger from shock and casting strains.

The other method for correcting the high-sulphur tendency in daily work at present and for that to come is a desulphurization process in which the regular cupola method is employed, the molten metal being transferred into an electric furnace having a basic lining. In this way the heavy current variations are avoided, and by taking advantage of the comparatively cheap cupola-melting cost, that of the electric furnace for refining only is very materially reduced. It is a question whether more than a quarter of a cent is thus added to the cupola-melting cost per pound of metal " duplexed," where current is cheap.

Molten cupola metal, with possibly 0.12 per cent sulphur, may thus be brought down to about 0.05 per cent, and even lower. Moreover, the metal is highly superheated—cupola metal itself is intensely hot as compared with furnace iron—and thoroughly deoxidized. The castings made are therefore much better and sounder than the ordinary run, equaling charcoal-iron castings made in the air furnace. The first cost of the installation is high, but it soon pays for itself in the quality of work turned out. While developed during the war period, it is none the less a logical sequence in the world advance of the art of making iron castings and should be welcomed as a satisfactory way out of a very bad situation ahead.

In conclusion, the mechanical engineer is urged to turn his attention more specifically to foundry operation. The technical staffs of all the foundries of continental Europe, from manager down to assistants in the several production and testing departments, are all graduate engineers. The consequence is that castings are made strictly for the purpose intended, and not merely to get by the machine shop safely, as is unfortunately so often the case here. Close coöperation between men trained in the science with those trained in the art of making castings can only result in good.

DISCUSSION AT CASTINGS SESSION

Gray-Iron Castings

H. Wade Hibbard,[1] who was the first to discuss the paper on Gray-Iron Castings, called attention to the author's statement that " cast iron is ideal for frames for machinery of all kinds, and as it can be locally chilled it gives splendid wearing surfaces," and stated that it had always been his impression that a special grade of cast iron was needed if a chilled surface was desired, and that the grade of cast iron used for frames for machinery was not the grade commonly employed. To this Doctor Moldenke replied that "chilled" may refer to one of two things. It may refer to an iron that has been turned perfectly white or an iron which is merely cooled sufficiently rapid to become coarse-grained.

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[1] Prof. Mech. Eng., Univ. of Mo., Mem. Am.Soc.M.E.

John McGeorge[2] referred to the author's statement regarding the transfer of the melted iron to the electric furnace having a basic lining and asked if the use of such a lining did not eliminate the phosphorus. Doctor Moldenke stated that the phosphorus was not eliminated, and that the carbon must first be removed, also that the sulphur must be eliminated.

Mr. T. A. Bovie inquired as to the strength of the iron and Doctor Moldenke replied that it depends upon the proportion of graphite and that of course, in general, as the total carbon content is decreased the strength is increased.

MALLEABLE CASTINGS

Captain Hughes, who opened the discussion on the paper on Malleable Castings, called attention to the author's statement that the Ordnance Department was unfamiliar with the physical characteristics of malleable iron. He stated that the Ordnance Department was planning at the present time to make drop bombs out of malleable iron but has been unable to obtain satisfactory castings, especially in the larger sizes, and that furthermore the Department has had great difficulty in inducing the malleable-iron castings companies to undertake the necessary research work. He requested information as to where the Department might possibly secure satisfactory castings.

Doctor Moldenke gave as his reason for unsatisfactory castings, the fact that a white-iron casting has a contraction from the molten to the solid of over 12 per cent, and unless it is possible to take care of that contraction in the feeding of the metal, the outside of the casting will be sound but the inside porous. He also spoke of Professor Touceda's work in assisting the smaller foundries to manufacture a uniform product.

Professor Hibbard stated that thick sections in malleable castings have been feared by the designer and objected to by the manufacturer and he was therefore interested in the author's statement that "castings have been produced commercially as long as 5 ft. with sections at some parts as thick as 3 in." "With certain of our malleable-iron foundries," he said, "the ability to produce malleable-iron sections as thick as 3 in. or more has been known for several decades, but since malleable iron before it is annealed is essentially white and very brittle, by putting a chilling piece into the sand mold where the section is thick, that chilling piece thus renders it more capable of receiving the annealing process." Professor Hibbard said he wondered if our foundries are acquainted with this method of causing a thick piece to lend itself readily to the annealing process. Doctor Moldenke replied to Professor Hibbard's inquiry and stated that to his knowledge this particular method was commonly known. Doctor Moldenke also stated that from his experience he had found that malleable castings could withstand shocks better than steel castings. "There is nothing better," he said, "than malleable under shock."

Replying to an inquiry as to whether or not any work had been done toward the casting of malleable iron in permanent molds. Doctor Moldenke said that in making railroad tie plates in the permanent or iron molds he invariably found that the material so made was weaker than that made in a sand mold. He related his experiences in the production of the tie plates and called attention to the difficulties encountered, particularly those arising from the rapidity with which the metal chilled in the iron mold. He stated that in his opinion permanent molds would never amount to very much. "We ought to aim in a different direction," he said, "and make molds of a substance that will not be injured by one, two, three, four or even ten molds."

Lieut. E. R. Jackson[3] requested information dealing with the use of malleable iron in connection with parts for tractors and motor trucks. "Out of twenty of the standardized trucks that we took across the country," he said, "there wasn't a single valve tap that completed the trip. They all had to be replaced." He referred to Professor Touceda's statement that malleable iron can replace such parts, but said that to date they have not been satisfactory in the Army. Doctor Moldenke replied to Lieut. Jackson's inquiry and stated that the difficulty was probably due to the fact that when a malleable casting is skinned a large portion of the carbon content is removed. "There is a difference," he said, "between the malleable casting of America and the malleable casting of Europe." In Europe it is the practice to almost completely remove the carbon and as a result they obtain practically a steel, which, of course, wears very well. Over here, however, our castings do not have the carbon removed and consequently do not wear so well.

STEEL CASTINGS

Professor Hibbard was the first to discuss the paper on Steel Castings. He called attention to the author's statement that "when the service demands all the strength, toughness and resistance to wear and fatigue that are obtainable in a cast metal, a steel casting should be specified." He stated that perhaps he had an undue prejudice against wearing or suitability of cast steel on a rubbing surface and that in his own practice he did not employ steel castings with finished surfaces for rubbing surfaces.

Lieut. Jackson endorsed Mr. Hibbard's remarks, stating, however, that the Ordnance Department has found forged steel parts quite satisfactory for such work.

Mr. McGeorge related an experience in the production of large castings which did not shrink although a very considerable shrinkage was expected. The cores were very hard and they did not crush. "The following castings were annealed," he said, "in a large furnace which we built for that purpose. We then obtained the proper shrinkage."

Doctor Moldenke said that while he was not very well posted on steel castings, he had had similar experience with cast iron. "If the core is too hard," he said, "either the metal must give or it cracks. That is one of the reasons why in our foundry practice, when we make a pattern, we first make a casting and break it and measure it, for we may have to change that pattern."

Professor Hibbard also commented on this phase of the work and called attention to the methods employed by the Commonwealth Steel Company.

Captain Hughes stated that at the present time a very interesting case of steel castings failing to shrink the anticipated amount is to be found in the making of recoil bands for 16-in. guns. "We used to make them solid," said Captain Hughes, "and then in order to get greater weight, we cored them out and filled them with lead. We made some castings which weighed about 25 tons, and were about 129 in. long and 77 in. wide. On the 129-in. dimension they were about 1¼ in. long, throwing off all holes, ribs and other parts of the casting, so that it is necessary to make new castings, which is due to this same phenomenon of being unable to shrink due to hard cores. We annealed these castings afterward and realized the physical properties desired which are those of the U. S. Cast Steel, No. 3, which, as you know, are very high."

[EDITOR'S NOTE: The time devoted to the discussion of the papers by Messrs. Moldenke, Touceda, and Hall consumed practically the entire time set aside for the Foundry Session, and those present at that session accordingly decided that the discussion of papers by Messrs. Pack, Jeffries, and Bierbaum should be in written form and included in the general account of the meeting. To date, however, but one discussion has been received. This is given below.]

BRASS AND BRONZE CASTINGS

ROBERT J. ANDERSON[4] (written). The paper by Mr. Bierbaum mentions the fact that in the case of manganese bronze sprue returns are exceptionally large—so much so that in the manufacture of ordinary automotive castings only about 17 to 39 per cent of the entire metal melted finally appears in the form of finished castings. In the other papers comprising the

(*Continued on page* 486.)

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[2] Special Engineer, Ohio Body and Blower Co., Cleveland, Ohio, Mem. Am.Soc.M.E.

[3] Tank, Tractor and Trailer Div., Ordnance Dept., Washington, D. C.

[4] Bureau of Mines, Experiment Station, Pittsburgh, Pa.

McCook Field and American Aeronautics

Inception of McCook Field and Nature of the Work Carried on—The Problem of the Variable-Pitch Propeller—Development of Measuring Instruments—Research Work in Altitude Flying— Present and Future Potentialities of the Field

By LEON CAMMEN,[1] NEW YORK, N. Y.

A MODERN aeroplane is far more than a few sticks of wood and canvas thrown together with an engine and propeller stuck in. In many respects the design of an aeroplane is a real course in post-graduate engineering, even for those who have done extensive work in other lines. The aeroplane is the lightest craft for the amount of power that it carries, moves at greater speed than any other passenger-carrying vehicle, and is subject to a greater variety of stresses and influences than any other structure know to man. Moreover, these stresses and influences, the character of which is as yet little known, are most difficult to determine.

Classical economics used to say that all production involves three basic elements: land, labor and capital. In aeroplane construction more perhaps than anywhere else the fourth element of production plays a tremendously important part, and that is—knowledge.

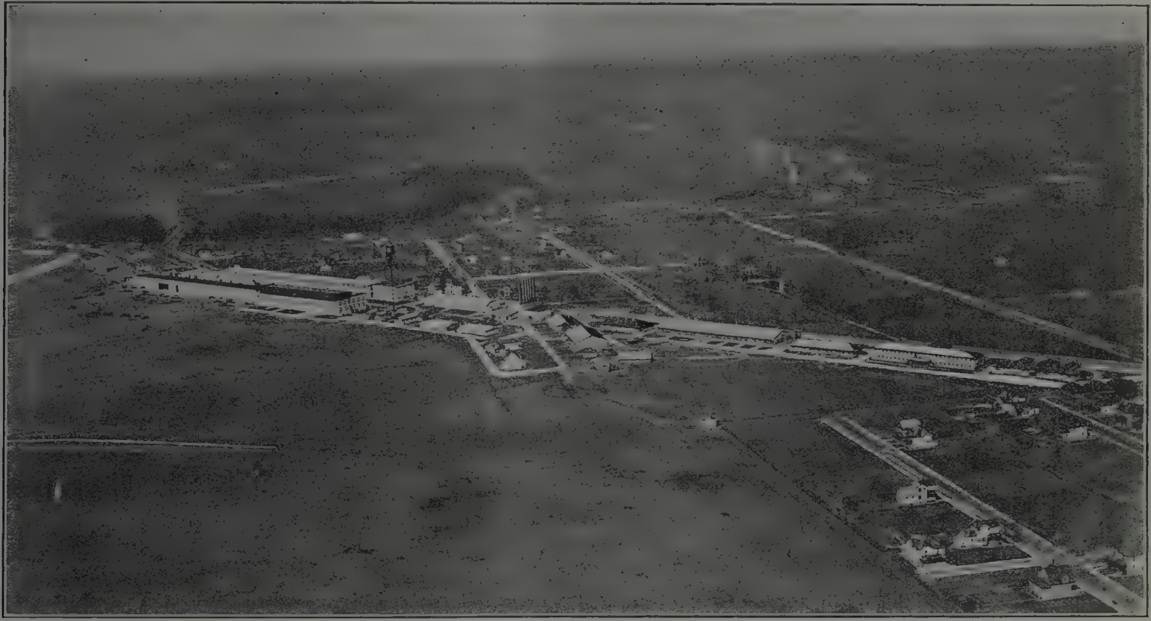

Fig. 1 Aerial View of McCook Field

Many delays in the execution of the American aeroplane program at the beginning of the war were due to the fact that we, in this country, did not have the accumulation of technical data, either theoretical or experimental, that was necessary to carry out the vast program undertaken, and that many of these data could not be secured even from abroad, where, notwithstanding all war regulations, they were a jealously guarded secret of commercial companies.

It takes a vast amount of painstaking work in experimenting, measuring, calculating and devising to secure data useful in aeroplane construction. Moreover most investigations bring in results in the form of tables, equations of stresses, or little matters of design which cannot be patented and made the exclusive property of some particular individual or company. Because of this, commercial aeronautic companies, such as there are, either do not undertake work of this character at all, or, if they do, guard the results as their trade secrets.

It is obvious, however, that if aeronautics is to be developed in this country there must be some place where investigations into matters pertaining to this new art can be carried on without any regard to immediate commercial returns. In other words, we have to have what practically amounts to a national laboratory for aeronautical research. In this direction a certain amount of work is being carried out in various institutions, but the place where such work is carried out probably on the largest scale is at McCook Field, Dayton, Ohio.

The Inception of McCook Field

The field happened to be located at that particular spot more or less accidentally. Since the days of Wilbur and Orville Wright, Dayton has, to a certain extent, been the aeronautical Detroit of the United States, and about the time of our entry into the war several companies located in that particular city were engaged in aeronautical work or in work having an important bearing on the art of flying. The War Department did its best to coöperate with them, and the original McCook Field was the result.

It was quite a modest endeavor at first; but with our entry into the world war and the great appropriations granted by Congress for aeronautics, McCook Field rapidly assumed its present great proportions and, in fact, became the center of the main engineering activities of the Air Service of the Army.

The aerial view of the Field, Fig. 1, gives an idea of the scale on which this enterprise was carried out under the stress of war conditions when so much depended on the Air Service arm of our fighting forces.

The chief work on the development of the Liberty engine from its beginning to the present stage was carried out at McCook Field and many other investigations of great importance have passed through various stages of development in the same great organization.

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[1] Associate Editor, Mechanical Engineering.

NATURE OF THE WORK CARRIED OUT AT MCCOOK FIELD

The work carried out at McCook Field is of an extremely varied nature and covers a wide variety of subjects, from trial flights in the course of which new equipment is being tested to the development of curves of performance of various apparatus, instruments of measurement, new devices and new laws in branches of engineering bearing on man flight.

During the war all that was done at the Field was naturally covered with the deepest veil of military secrecy, and even now research is carried on along lines and on subjects which are not yet ready for publication. A tremendous amount of work has been done, however, which can now be revealed. It may be stated, in this connection, that as far as possible the authorities at McCook Field never tried to make more of a mystery of their work than was absolutely called for either by the exigencies of war or the necessity for reticence about work yet in progress.

The Bulletin of the Airplane Engineering Department, U. S. A., and the Technical Orders of the Engineering Division, Air Service, Dayton, Ohio, available now to every American engineer who can show a bona-fide desire to use them for the good of the country, represent a very valuable source of information on research in the aeronautical field.

It was at the McCook Field, in coöperation with the Forest Research Laboratory, that the whole subject of veneers, plywood, and glue in aeroplane construction received the development which, in this connection, gave the United States the foremost position that it now occupies in the world. There were several other problems that were carried to completion at the Field. One of the first that may be mentioned is that of supercharging. Since the early days of the war it was noticed that engines, as they then were, lost a large proportion of their power at high altitudes. A partial solution was offered by the supercharger as built by Dr. A. Rateau, Hon. Mem. Am. Soc. M. E., in France, but further work was necessary before the apparatus could be made practical. The theoretical part of this work was carried out in the Altitude Laboratory of the Bureau of Standards, but it remained for the engineers of McCook Field to do the practical work—in coöperation with Mr. E. H. Sherbondy, of the De Laval Company, and especially Dr. Sanford A. Moss, Mem. Am. Soc. M. E., of the General Electric Company. The Moss supercharger was the one which was finally brought to the practical stage and important flights were made with it from McCook Field. The exact value of the supercharger on aeroplanes may not yet be clear, but there is scarcely any doubt as to its representing an important advance in the engineering of high-altitude flight. Another development of importance, the magnitude of which it is scarcely possible to realize today, is represented by the so-called variable-pitch propeller.

THE PROBLEM OF THE VARIABLE-PITCH PROPELLER

The efficiency of an aeroplane propeller depends on so many variables that it is practically impossible to design a propeller that will be equally efficient under all conditions. The propellers used today represent nothing but compromises designed to give the best efficiency under the average conditions under which the aeroplane is supposed to fly. This, however, deprives the aeroplane of a good deal of its flexibility and, for example, makes one designed to fly at moderate altitudes highly efficient at high altitudes, and vice versa. If we could make a propeller with a variable pitch and vary the pitch from the seat, it is obvious that we would have a means for adapting the propeller to the varying conditions of flight, and would give the aeroplane somewhat the same flexibility that the change gear gives to the automobile of today. The problem, though comparatively simple theoretically, proved to be a very puzzling one when it came to practical developments. It must be remembered in this connection that the variable-pitch propeller gear must be of light weight and yet have a high factor of reliability, and that the latter is made particularly difficult because of the fact that the amount of power transmitted through the gear is quite large—for example, with the Liberty motor, 400 hp. or more as compared with some 60 to 80 hp. that the change gear of an ordinary large automobile has to carry. A still further problem lay in the fact that a wooden propeller had to be made in two sections engaged with the variable-pitch gear and that means had to be found to hold the wooden parts in such a manner as to withstand the tremendous stresses induced by the centrifugal forces acting on the propeller and otherwise.

It would not be an exaggeration in any way to say that the development of a variable-pitch propeller installation represents as difficult a job in mechanical design as any that had to be tackled in the development of modern aeroplanes and its practical solution may be viewed with pride by the American engineering fraternity. This all the more so, as it may be expected that ultimately the solution of the variable-pitch propeller problem may lead not only to the improvement in the overall efficiency and flexibility of operation of the aeroplane but also to the solution of one of the most vital problems in aeronautics of today—the problem of insuring safety in landing.

To maintain itself in the air an aeroplane has to fly at a certain minimum speed. If that speed goes below the necessary minimum limit, the aeroplane will fall to the ground like a plummet, and this is what makes landing so difficult and dangerous. A high speed, varying from 30 miles for large and slow-going planes to some 60 miles or even more for the small, extremely fast machines, must be maintained up to the very instant the wheels touch the ground, and it is obvious that unless some way is found for braking an aeroplane, it will continue to move for quite a considerable time at the same speed after reaching the ground. An aeroplane, however, is not designed to run at very high speeds on the ground unless it is very smooth and even, and running on rough ground is apt to cause trouble either by breaking the landing gear or upsetting the plane. As a matter of fact, the extremely high-speed scout planes can land safely only on specially prepared landing fields.

The situation is about the same as if automobiles without brakes were permitted to travel at, say, 50 m.p.h., and it is easy to see how dangerous a pursuit motoring would have been under these conditions. There has been no lack of effort to provide braking for aeroplanes, but, unfortunately, practically all attempts in this direction have failed for one reason or another. However, there is what appears to be an entirely practical way of handling this problem and that is by using the aeroplane propeller itself as a brake, which means reversing the propeller at or immediately after the instant of landing on the ground. This requires that means for reversing the propeller and controlling its operation in the reverse condition should be available, and that is what the McCook Field work on variable-pitch propellers promises to give us.

It may be said that for work of this and similar character on propellers there are available at the Field unusually good facilities, and actual-size propellers can be tested in various ways with instruments necessary to determine the main features of propeller performance.

DEVELOPMENT OF MEASURING INSTRUMENTS AT MCCOOK FIELD

Another field in which a large amount of highly interesting work is carried on is that of instruments. In the early days scarcely any instruments were used in power-plant engineering work. Coal was weighed after a fashion and in some plants pressure gages were employed. The thermometer was also used, though grudgingly, and in a few laboratories rather crude dynamometer facilities were available on a limited scale.

It was the introduction of electric power generation and transmission which really laid the foundation for the modern view as to the importance of measuring instruments. The transmission and application of electric power was not feasible without instruments, such as ammeters, voltmeters and wattmeters, and when it came to alternating currents, frequency meters, etc. In this way the amount of power delivered to the generators was measured and known and this induced a feeling of curiosity as to what was happening at the steam end, which led to the more extensive use of the indicator first and to the development of

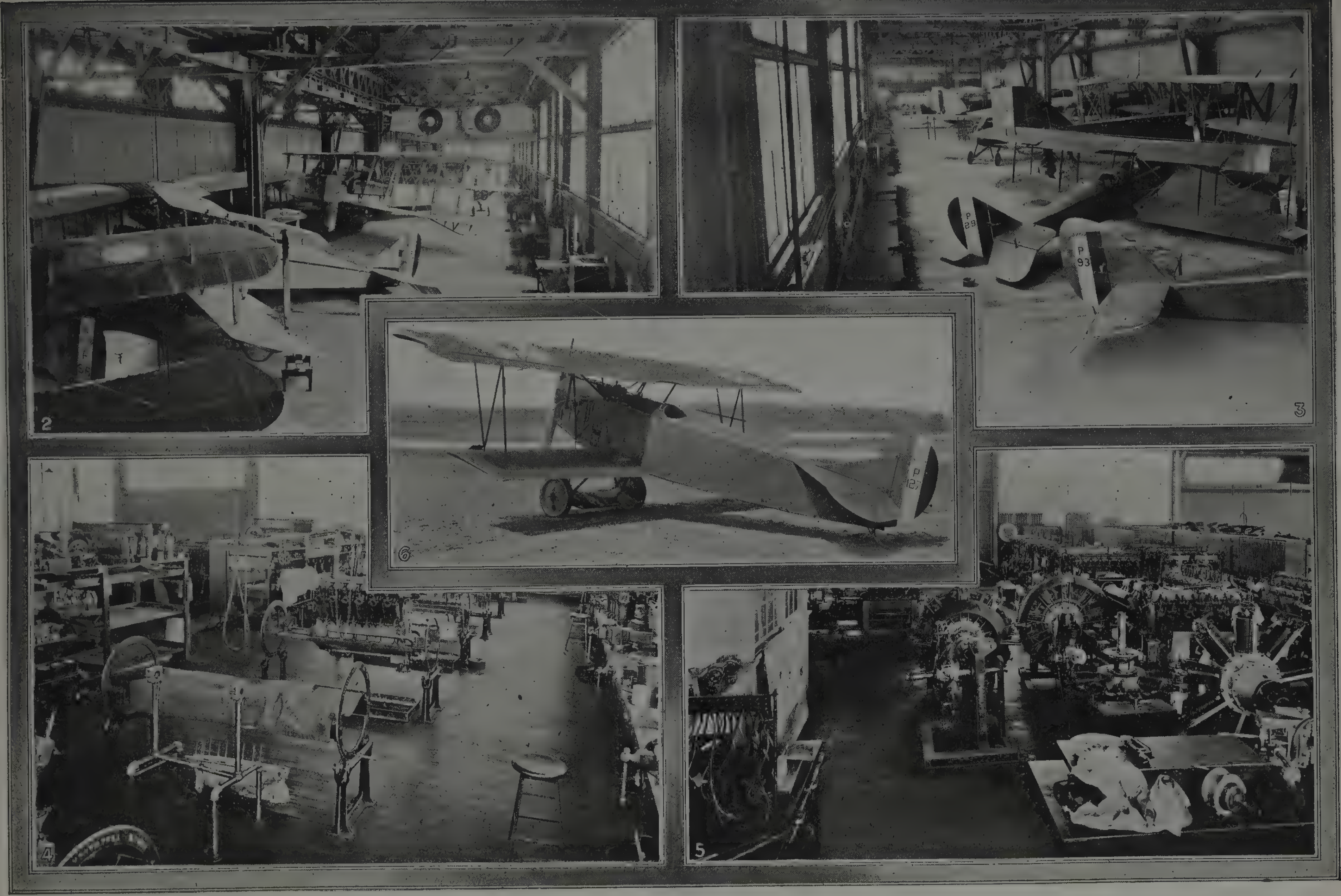


FIG. 2 VIEW IN HANGAR SHOWING MACHINES UNDER TEST
FIG. 4 ENGINE OVERHAUL STANDS AND BENCHES

FIG. 3 VIEW IN HANGAR SHOWING MACHINES UNDER TEST
FIG. 5 VIEW SHOWING INTERIOR OF ENGINE MUSEUM

FIG. 6 FOKKER WITH LIBERTY-6 ENGINE

the present varied and highly efficient instruments for measuring and recording water and coal consumption, exhaust-gas analysis, temperatures at the various stages and other elements. But even these relatively highly organized methods of measurement appear crude when compared with the vast metrical work that is being carried on in connection with aeronautics. There man has projected himself into a world of which very little is known, and what little information is available is either incomplete or misleading. Everything about the air composing the upper strata of the atmosphere as well as about the vehicle in which man goes up into the air has to be learned anew, which means that new and precise instruments have to be developed.

The work of developing these instruments is being carried on vigorously at McCook Field and recently, for example, a new instrument was developed permitting the recording of altitude with a precision many times greater than has hitherto been possible. The time has not arrived, however, for telling more than what has just been stated regarding this branch of work, which, by the way, has a particularly great importance for the American aeronautical industry, as comparatively little is known about foreign developments in instrument manufacture since the armistice.

A good deal of the design work in connection with development of planes and their testing is also carried on at the Field, which has good facilities therefor. Likewise, important work is carried on in connection with the design of military accessories, but of this branch the less said the better.

Research Work in Altitude Flying

There is, however, one line of research which deserves particular attention. At the present writing a member of the McCook Field Flying Force holds the world's record for altitude flight, and, what is most important, altitude flying as carried out at the Field does not have the sole purpose of establishing records; as a matter of fact, the sporting element is kept entirely in the background.

For the Field, altitude flying is a grim business. They are developing the machinery to make altitude flying possible if the exigencies of war or aerial commerce should make it necessary. The flying is done with supercharged engines, which necessitate a number of inventions to make this new type of internal-combustion motor fully reliable to operate under the unusual and strenuous conditions prevailing at a height of several miles above sea level.

Then again, military authorities want to know just what is going on in the air at such altitudes, and it is already apparent that some of the phenomena occurring there are of vital and unexpected importance. They are not telling all they have learned and they should not. But one of the things which may be told is that winds of unsuspected velocities, ranging perhaps as high as 250 or more miles an hour, have been discovered blowing from west to east. Whether winds blowing in the other direction with similar velocities can be found remains yet to be seen, but even with the knowledge which we now have it appears perfectly feasible to go up in the air in California and land around New York within, say, 10 to 12 hours from the start.

Present and Future Potentialities of McCook Field

McCook Field, however, is more than a research organization of the War Department. If it is not so already, it nevertheless has a nucleus of the possibility of becoming what might be called a national post-graduate research laboratory in aeronautics.

There is one room in the Field (Fig. 5) which makes an engineer connected with aeronautical research think. This spacious, splendidly lighted room has on its floor practically every aeronautical engine of importance—Liberties of several types, the big Sunbeams, Gnome engines as dainty as a Swiss watch, a sturdy German Mercedes. All of these can be studied there and a visit may save months of research and trouble to any one connected with the design of aeronautical engines. It is certainly the most complete engine museum in this country, perhaps in the world, and one cannot help thinking what a splendid thing it would have been for American aeronautical engineering if side by side with the engine museum were other halls containing similar collections of propellers, wing sections and aeronautical accessories, and these backed by the courteous and expert staff on the Field. It may be mentioned, in this connection, that while there are sections of the Field closed to visitors as they should be, any person who can show a legitimate reason for inspecting those parts of the Field that do not fall under this restriction can easily obtain access to them. There is but little red tape about admission and the engineers and employees appear to be ready to help out any one expressing a fair reason for coming there. This is all the more worthy of note as the present staff is none too numerous for the work being done.

There is a good deal of talk now about Government assistance to aeronautics. The experience of France and England, for example, has shown that the art is yet too new and the commercial possibilities of aeronautics too limited and uncertain to develop without some form of Government assistance. Whether this will prove to be the case also in this country is a matter worthy of the most serious consideration. There is one form of Government assistance, however, the value of which will hardly be questioned, and that is assistance along the lines of research which no commercial concern can undertake.

McCook Field as it stands, together with the Aeronautical Laboratory of the Bureau of Standards, the Forest Laboratory at Madison, Wis., the testing fields of the Navy, already represents a powerful stimulus to the development of the art and science of aeronautics in this country.

A visitor to the Field cannot help being impressed with the fact that the actual coefficient of utilization of the Field is at present very low. The organization was conceived on a big scale in accordance with the vast American aeronautic problem of war time, and only a skeleton of it is maintained, and yet there is room and need for an organization even larger than that of the original McCook Field plan. In the field of aeronautical research undoubtedly good work has been done in this country, but the art is advancing by leaps and bounds and unless we keep up with it we are in danger of being left behind just as we were in the years 1914-1917.

It might be well, perhaps, to remember that the world's conditions are still extremely unsettled, and that it would really be a bold man who would dare to prophesy that this country will be confronted within the life of the present generation with an emergency similar to that of February, 1917. The development of aeronautical engineering as carried on by institutions like McCook Field is not a cheap proposition. On the other hand, however, it does not require any sums that might in the least prove to be burdensome to a country as wealthy as ours, and the value of such an investment would be repaid a thousandfold in many ways, especially if we should have the misfortune, together with the rest of the world, to be faced with a grave war emergency in the future.

The New England Pulp and Paper Industry

The pulp and paper industry of New England probably ranks third in money value of product; the textile and shoe and leather trades leading, but, from the traffic viewpoint, pulp and paper with the immense raw material tonnage involved in their manufacture easily lead all our industries. A "balanced" book paper mill, for example, involves about seven tons inbound for each ton of final product—a "balanced" mill meaning a plant producing its own sulphite and soda pulp and its own bleach and alkali by electrolysis. Thus a "balanced" mill with 250 tons daily product involves a total shipping tonnage of 600,000 tons per year.

With certain undoubted advantages for the manufacture of paper, New England also has some serious disadvantages. The mills have long hauls inbound on coal and many important raw materials of heavy tonnage, and outbound on much of their manufactured product. New England produces many times its own requirements of paper, and while the home market is important, and New York City is much the largest paper market on the continent, the center of consumption is very far west of there.

Pipe Lines for Transporting Natural Gas

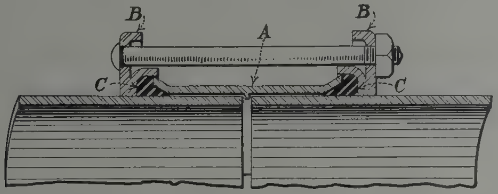
The Construction, Repair and Operation of Jointed and Welded Lines, Including Particulars Regarding the Couplings Used, Pipe-Laying Machines, Strength of Welded Pipe, Pressure Regulation, etc.

By CLIFFORD E. BROCK[1], BARTLESVILLE, OKLA.

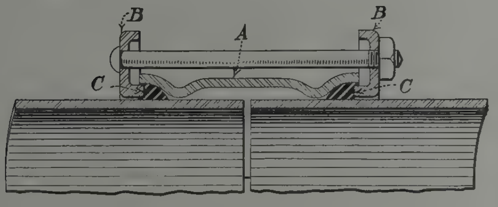
DURING the early development of the natural-gas industry many different styles of pipe and joints were used. The first line, a small wooden one, was laid in Pennsylvania in 1872. Small screw lines were next used, and these were followed by leaded-joint lines, which later developed into the rubber-gasket joint of the present day.

A coupling for plain-end pipe consists of a center ring *A*, two followers *B*, and two rubber gaskets *C*, as shown in Fig. 1. When laying coupling line, skids are placed across the ditch and the pipe, according to size and weight, is either carried or rolled on these skids. One follower, one gasket, and the center ring are placed on the first joint, and the other follower and gasket are put on the next joint, the latter being fitted into the center ring on the first joint. Bolts are then placed through the followers and are drawn up against the center ring, forcing the gaskets against the center ring and pipe and thus making a tight joint. After a section of line has been laid, it is lifted off the skids by means of short scaffolds or horses and lowered into the ditch as the skids are removed (see Fig. 2). Great care must be exercised in lowering coupling lines, or the joints will be strained and leaks develop.

Many different styles of couplings have been used, starting with cast-iron couplings, which make excellent joints but are too heavy and easily cracked if strained when the pipe is lowered into the ditch. Practically all couplings used today, however, are made of steel and with either outside followers, which fit over the center ring, or with inside followers, which fit under the center ring. See Fig. 1.



Outside Follower



Inside Follower

Fig. 1 Types of Couplings for Plain-End Pipe

It is the writer's belief that the outside-follower coupling is the most practical, for the reason that it is impossible for the rubber to blow out between the follower and the center ring; while with an inside follower a part of the rubber is pushed over the follower and there is nothing to prevent the rubber from blowing out between the follower and the center ring, in which case the gas flow cannot be shut off temporarily with wooden wedges while repairs are being made.

Repairing Coupling Lines

Leaks on coupling lines occur from three different causes, namely, rubber blowing out, cracked center rings, or broken followers; and in case the leak is of any consequence it can be repaired without interrupting the service by installing an emergency sleeve over the coupling.

This emergency sleeve (Fig. 3) is made in six pieces, two large halves and four half-followers, which, when joined together, make a joint similar to a coupling. The large halves also have inside rubbers which make them gastight, as well as a relief valve located in the top half through which the gas flows while the repair is being made. When the repair work is completed the valve is closed, making a tight joint. The sleeves are left on until it is convenient to shut the line out to remove them and repair or replace the coupling.

Fig. 2 Lowering Coupling Line Into Ditch

With the development of natural gas in the Mid-Continent field it was found that the rubbers heretofore used in coupling lines were affected by the gasoline in the gas, and after a short time were eaten out. About six years ago gasoline-proof rubbers were put on the market, and practically all lines laid with these rubbers have given very little trouble. These rubbers have a tendency to enlarge when saturated with gasoline, and in this way make a very tight joint. On a pipe-line system in California it was found that after a gasoline plant was installed, leaks occurred along the line due to shrinkage caused by the rubbers drying out, and it became necessary to bypass the gasoline plant occasionally and allow the rubbers to become saturated with gasoline until they had swelled sufficiently to shut off the leakage.

The great advantage in laying coupling line is the speed with which it can be laid. There is practically no limit to the amount of any size of plain-end pipe that can be laid in one day, except the number of men that can be employed on the work. While screw pipe will carry higher pressures than plain-end pipe, the following results obtained in tests show that plain-end lines will carry the high pressures employed with a good margin of safety:

Size, in.	6	8	10	12	16	18
Weight, lb.	17	24	32	42	48	53
Pressure, lb. per sq. in.	450	400	400	350	325	300

Welded Lines

In the natural-gas business a large amount of screw pipe and casing becomes unserviceable after being used once or twice, unless it is rethreaded and new collars put on. To eliminate this expense by utilizing casing unfit for further employment in drill-

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Presented at a meeting of the Mid-Continent Section of The American Society of Mechanical Engineers, Bartlesville, Okla., October 30, 1919.

ing, experiments in laying welded pipe lines were started in 1916.

Several small lines were laid in the Mid-Continent field, and gas men were so well pleased with the results that attempts at welding large lines were made. A 10-in. line was laid by the Wichita Pipeline Company from Drumright to Cushing, on which very few leaks have occurred since its completion. The Oklahoma Natural Gas Company laid a 10-in. line from Dilworth to Enid with good results, allowance being made for expansion and contraction by digging a wide ditch and blocking the line first on one side of the ditch, then on the other. Later the blocks were burned, leaving sufficient slack in the line to care for all the expansion or contraction.

In 1917 the Wichita Natural Gas Company laid a 12-in. line from the El Dorado field to Valley Center, Kan., but this line did not give as good results as the 10-in. line mentioned. A great many breaks occurred, and in places this line would pull apart three or four inches.

Another 12-in. line laid by the Empire Gas and Pipeline Company from Bigheart to Hominy, Okla., also gave considerable trouble, breaking as often as sixteen times in twenty-four hours.

All of the above-mentioned lines were laid without expansion sleeves or couplings, and after watching closely the operation of these lines, it is the opinion of the writer that it is impracticable to lay welded lines larger than 10 in. without allowing for expansion and contraction.

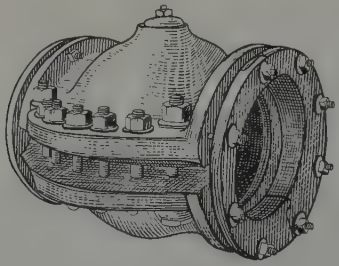

FIG. 3 EMERGENCY SLEEVE FOR REPAIRING LEAKS ON COUPLING LINES

The process of laying welded lines must necessarily be slow on account of the time required to make a weld and the scarcity of good welders. The field is full of welders who are graduates of welding schools where they are taught to weld castings and flat steel, but these men must be taught how to weld pipe after they reach the job.

Large lines are usually welded in sections of six or eight joints before lowering into the ditch, and bell holes dug to weld the line solid. This process saves much time and digging, and gives the welder a chance to roll the pipe while welding rather than lay on his back in the ditch to weld the bottom of the joint.

The two principal welding irons used are vanadium steel and Norway iron, both of which are good, but better results are obtained with the latter on account of its being a softer metal.

The greatest drawback to welded lines is the great inconvenience and danger in repairing a break. It is almost impossible to repair a cracked weld with high pressure in the line, for two reasons: First, if the crack is very large, the gas pressure will be too great to permit the use of an emergency sleeve; second, if the top half of the sleeve is accidentally dropped on the pipe, the weld is likely to give away entirely, allowing a large volume of gas to escape and blow the top half of the sleeve and the men out of the ditch. In order to avoid such danger the writer has found it advisable to instruct all field men to always shut out and drain a welded line before attempting repairs, which of course would be disastrous to the service if the line were the only source of supply to the market.

The writer does not recommend welded lines in sizes larger than 8 in. without using a coupling or expansion sleeve every six or eight joints, but lines smaller than 8 in. can be laid successfully, and in connection work, such as Y's, tees, ells, etc., welded work can be depended upon and, if properly done, a great saving effected.

Excellent results have been obtained with the welding process in building meter stations, regulator stations, gasoline plants and refineries, in the construction of which it is necessary to do a large amount of pipe fitting, which, when threaded nipples and flanges are employed, is slow and expensive.

In pipe-line work it is more practical to use acetylene and oxygen in tanks on account of the necessity of moving often, but in stationary work an acetylene generator can be used and the acetylene generated at about half the cost when supplied in tanks.

Table 1 gives results of tests made by the Kansas City Testing Laboratory, and shows the relative strength of the weld to the pipe.

TABLE 1 STRENGTH OF PIPE WELDS

WELDING ROD TESTS

Description	Elastic limit, lb. per sq. in.	Ultimate strength, lb. per sq. in.	Elongation, per cent in 8 in.	Reduction of area, per cent.	Per cent of elastic limit of pipe sample.	Per cent of ultimate strength of pipe sample.
Vanadium No. 1..........	46250	56870	11	75	....	....
Vanadium No. 2..........	75360	79600	10	75	....	....
Norway No. 1............	42600	50300	35	60	....	....
Norway No. 2............	63620	59200	20	75	....	....

PIPE AND WELD TESTS

Description	Elastic limit, lb. per sq. in.	Ultimate strength, lb. per sq. in.	Elongation, per cent in 8 in.	Reduction of area, per cent.	Per cent of elastic limit of pipe sample.	Per cent of ultimate strength of pipe sample.
Pipe Sample No. 1........	48000	56360	22	40	....	....
Welded Sample No. 1...	46350	54660	8	21	96	97
Welded Sample No. 2...	38800	38800	0	0	81	69
Welded Sample No. 3...	37600	41000	3	12	88.3	72.6
Welded Sample No. 4...	31940	31940	0	0	67	54.5
Pipe Sample No. 2........	42280	60080	22	40	....	....
Welded Sample No. 1...	39400	44620	3	16	93.5	74.3
Welded Sample No. 2...	38680	42800	3	12	91.5	71.4
Welded Sample No. 3...	38080	51190	5	18	90.1	85.3
Welded Sample No. 4...	33950	47750	6	11	80.2	74.1

SCREW LINES

Screw lines are laid by two different methods, by hand and by machine. In laying pipe by hand, one of the gang, known as the "stabber," starts the joint pipe into the collar of the preceding joint, and rolls it by hand for several threads to see that it is not cross-threaded. The joint is then screwed up as far as possible with a snubbing rope, and tongs are used to tighten it. These tongs are provided with a square key let into the shorter jaw crosswise, the exposed corner serving to grip the pipe, and this key can be very easily turned to expose a fresh corner or replaced. Before laying screw pipe the threads should be oiled with a heavy oil or pipe dope, which will aid in screwing up the joint and will also preserve the threads and make the joints easy to break when reclaiming a line.

Screw-connection work where only flange unions are used is a very particular job, requiring great patience and accuracy, but when completed makes the best connections. However, a large amount of screw-connection work is finally connected with a solid steel sleeve similar to a plain-end coupling but of greater length, to allow for expansion or contraction.

Several machines are manufactured by means of which it is possible to lay screw lines by power. This method is much faster than laying with tongs, but requires careful supervision to avoid screwing up a joint cross-threaded or burning the threads by running up a joint too fast.

PIPE-LAYING MACHINES

The two pipe machines most used in the Mid-Continent field are the "Buckeye" and "Mahoney," or California pipe machine. The Buckeye machine moves on caterpillars, and the pipe is laid from its rear end. The Mahoney machine is not equipped with caterpillars but moves on the pipe by means of a traveling gear operated by a clutch. When a joint has been laid a jack is placed under its head end and the machine moves forward to the end of the joint by means of the traveling gear. The machine is also equipped with a jack on which it is raised by power to take the weight off the pipe while another joint is being screwed up. Two sets of tongs are located on the front end, one for back-ups to hold the joint previously laid, and another to tighten the next joint. When it is desired to make an over-bend in the pipe, it is merely necessary to place a jack under the pipe at the point where the bend is to be made and run the machine ahead far enough to give the desired weight to make the bend. An attachment may also be purchased for these machines with which it is possible to make a sag bend in the pipe. This is done by the use of a 10-ton hydraulic jack operated by power from the motor. A force of fifteen or twenty men can operate the Mahoney machine, and where the country is fairly level a great deal of time can be saved, as it is possible to lay from thirty to forty joints an hour.

Screw pipe, while used in laying small gas lines, is used exclusively in laying oil lines, as a much higher pressure can be maintained on a screw line than on a coupling or plain-end line, and after a time rubbers in a coupling line will become affected by the oil. There is also considerably less friction in a screw line than in a coupling line, due to the different design of the joints.

General

In laying gas pipe lines there are many details which aid efficient and continuous operation of a line.

When connecting wells in a field it is always good policy to install a check valve at the point where the well line connects to the main line, to avoid a loss of gas in case of a break in the well line, or gate or tubing in the well.

In fields where salt water or gasoline is encountered with the gas it is necessary to install traps or drips to catch the fluid before it reaches the main line, as fluid affects measurement of the gas, regulation of pressure and operation of compressing stations, and at times even reaches the consumer's meter. A great many different types of drips have been designed, but all perform in practically the same manner—that is, they allow the gas to expand and decrease in velocity, which causes precipitation of the entrained fluid.

When constructing a main pipe line it is advisable to install a main-line gate every four or five miles, with a relief valve and pressure-gage tap on each side of the main-line gate. When a line is so laid it is possible, in case of a break, to shut out a short section of the line and exhaust the gas through the relief valves without draining the entire line and discontinuing service to consumers on sections of the line not affected by the break. With the gage taps it is possible for the man supervising the repair to observe the pressure being maintained on either side of the break.

In constructing river crossings for pipe lines which must give continuous service, it is always advisable to lay more than one crossing. The lines in the river can be of smaller pipe than the main line, but the total capacity should equal that of the main line. River crossings should be laid in deep water when possible, as the greater depth will lessen the danger of having the line torn out by drift. A line should never be laid straight across a stream, but swung in an arc upstream, the radius of the arc varying with the length of the crossing. In this manner the resistance of the line is greatly increased and many breaks avoided.

River lines are usually laid of screw pipe and each collar covered with a river clamp (Fig. 4), which removes all strain from the joint and adds weight to the line.

Occasionally welded river crossings are constructed, and in this case a split emergency sleeve, or a river clamp which has a rubber packing similar to that of an emergency sleeve, should be used, as it would be impossible to repair a welded crossing without first removing it from the water or without constructing cofferdams.

Operating a Pipe-Line System

In operating a gas pipe-line system it is good practice to carry the lowest pressure with which it is possible to handle the market, and in cases where small towns are located some distance from the main line and are supplied by smaller lines, regulators are installed at the main line and the pressure reduced rather than carry main-line pressure to the town limits.

In the operation of a natural-gas system it is impossible to turn in all gas available and allow it to go where it will, as the consumers on one part of the system would have an oversupply of fuel, while those on another part would suffer from shortage. To avoid such unequal service, gas companies maintain what is usually known as a dispatcher's office. Here pressure reports are received by telephone from all important points on the system at certain intervals during the day, and by carefully tabulating and observing these pressures, it is possible by regulation of the gas to maintain sufficient pressures throughout the entire system. In case of line breaks or line shut-outs for any reason, the field men are required to notify the dispatcher's office before a line is taken out of service in order that the service may be maintained by supplying from another source. In fact, the duties of a pressure dispatcher parallel those of a train dispatcher, and all wells, lines and regulators are operated upon orders from him.

In the operation of a pipe-line system the entire effort of the organization is devoted to giving continuous service, and in order to do this men are stationed at various places along the system. The lines are patrolled continuously by line walkers, who repair small leaks as they find them and report to their immediate superior leaks which they cannot repair. In such cases a crew is taken to the leak at the earliest possible moment to make the repairs.

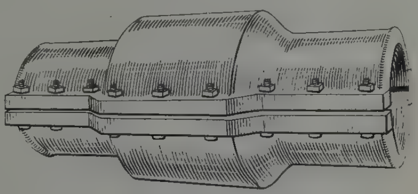

Fig. 4 Clamp Used to Cover Collars of Screw-Pipe River Crossings

It is seldom realized that while many homes are comfortably warmed by natural gas, it is often necessary for pipe-line repair gangs to be out night after night working to keep the lines together and prevent gas shortage. In fact, the gas consumer seldom hears of a break or leak on the gas line from which he receives his supply, due to the efficiency which must necessarily be maintained in a pipe-line organization.

The methods employed during the war of applying the electrodeposition of iron to the repair of motor vehicles were described recently before the Institution of Automobile Engineers by Mr. B. H. Thomas, who instituted the process. It was found possible to deposit a layer of iron up to about 2mm. in actual thickness on any simple cylindrical surface of wrought iron or steel, mild or cast. If the work is properly done this layer is firmly adherent, and it is practically impossible to chip it away with hammer and chisel from the basis metal. It is deposited direct on the surface without preliminary coppering, and can be subjected to red heat without apparent deterioration. It can be carbonized and hardened in the ordinary way. The layer presents an extremely smooth surface, and the thickness put on in a given time can be predicted with considerable accuracy. It can be filed or ground, and takes a high finish. It is perfectly satisfactory on such parts as brake and clutch shaft ends and starting handle spindles, and there is no obvious reason why it should not be satisfactory for building up worn journals.

The Engineer and the Woodworking Industry

A Great Industry in Which There Exists an Urgent Need of Engineering Skill

By THOMAS D. PERRY,[1] GRAND RAPIDS, MICH.

The lack of the application of engineering principles and practice to the woodworking industry has been felt very strongly by a group of Grand Rapids members of The American Society of Mechanical Engineers. One of these, Mr. Thomas D. Perry, has prepared the following article, outlining the scope of woodworking field and presenting some of the engineering problems involved, with a view of opening the subject for discussion and as a preliminary to a possible session on woodworking at a later meeting.—EDITOR.

WOODWORKING, one of the oldest civilized trades, is now one of the largest industries in the United States. It is doubtful whether any other major group of modern manufacturers gives evidence of less scientific knowledge of its products. The reason for this is quite apparent.

Agriculture has been very slow in adopting scientific means to improve the efficiency of its workmen because son could easily follow father with no special training. Carpenters' sons could do likewise; hence, a few branches of rudimentary woodworking were not at all difficult to acquire. In each case one or two or a half-dozen men could complete the finished product and no extensive organization, capital or costly machinery was necessary.

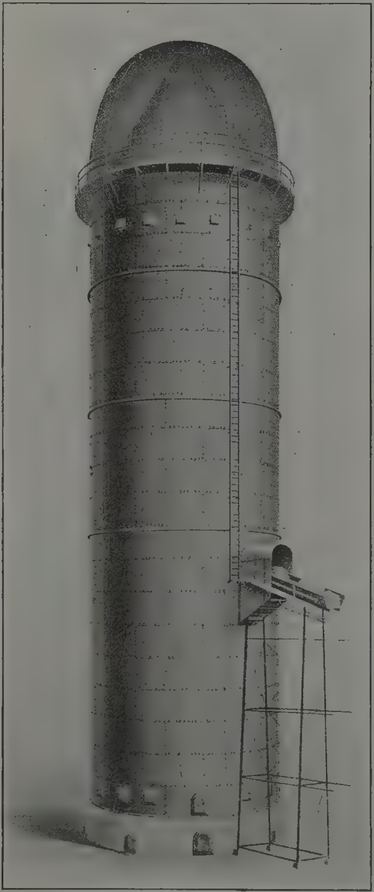

FIG. 1 THE MUSKEGON REFUSE BURNER

The problem of the metal worker was far different. The necessary processes were complex and expensive. They demanded skill for the many necessary steps between the iron ore and the rolled boiler plate or the seamless boiler tube. It was therefore quite natural that the engineer was attracted to the intricate and involved problems of the metal worker, and that the metal worker, in his turn, felt the need of the trained scientist.

A survey, no matter how superficial, will demonstrate that, while the woodworker may not have needed the engineer in the past, he certainly needs him now. Raw material is increasingly more valuable; and wasteful methods are increasingly more culpable; labor requires higher wages; mechanical methods are in demand; manufacturing units are larger; need for coördination is more pressing; and output is more standardized. Proper adjustments to meet these conditions will permit larger and more intensive production.

The woodworker is by no means wholly to blame for not desiring or utilizing engineering knowledge. The engineer seems to have considered that such simple problems as those of the woodworker were beneath his dignity and not worth while. It follows, therefore, that if the woodworking industry and the engineering profession are to be of mutual benefit, a broader aspect and a complete readjustment of attitude are necessary.

It may be of interest to enumerate a few of the branches of the woodworking industry and suggest a few of the problems that need better solutions. The fundamental division is between primary woodworkers, converting timber and logs (natural growths) into lumber or some other form of raw material intermediate between the tree and the final product; and secondary woodworkers, who take the lumber and make it into pianos, furniture, caskets, house trim, etc. The problems are quite unlike, although there may be a few exceptions where the primary manufacturer still produces the finished product, as in the case of cooperage and flooring and many kitchen implements made directly from the log.

The sawmill operator has the problem of bringing logs to the mill, which includes hill and valley logging, land and swamp skidding, rail and water hauling, all more or less complicated by the rotation of the seasons and the variations of the weather. Considerable engineering skill has been shown in some of these problems, mostly, however, in the direction of machine design. The utilization of waste in such plants stands out as a gigantic travesty on the principles of economy. It is frequently said that steam power does not cost the sawmill man anything because he has plenty of waste, therefore, why watch the economies of steam consumption!

Nearly every sawmill has a large waste burner (Fig. 1) to consume the refuse so that the burning of the waste will not be an undue hazard to mill buildings and lumber yards. Temperatures of 800 deg. are not unusual in these burners. The better class of waste is put under the boilers and the remainder in the waste burner, by means of which untold potential power is dissipated. The waste from trimming trees in the woods is left where it offers fuel for forest fires. In a few instances the author has known of the utilization of mill and woods waste for power production such as the manufacture of artificial ice in southern states and for making wood fiber for wrapping papers. These few instances, however, are exceptions to the rule of universal and unjustifiable waste in lumber production.

The rotary cutting, slicing and sawing of veneers is subject to all of the above problems, and in addition has several refinements such as preparing, cutting and handling thin and delicate sheets, selecting for figure, preventing discoloration, keeping flat, etc.

Another question, which needs the attention of the engineer is that of artificial drying. The problem of establishing the conditions of heat and circulation are not so difficult, but the tendency of the wood to dry too rapidly on the surface and establish

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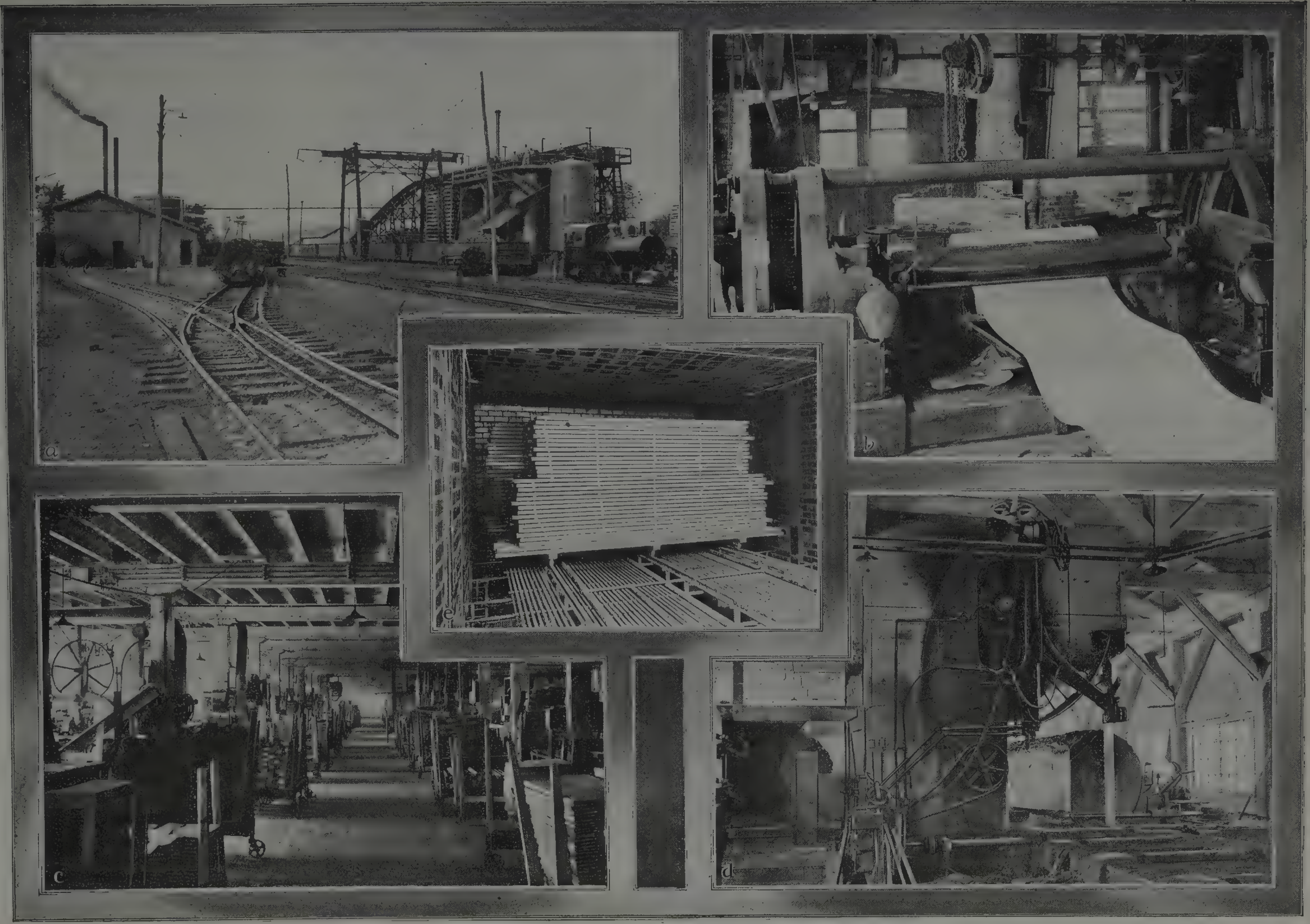


Fig. 2 Typical Views in Wood-Treating and Woodworking Establishments

(*a*) Typical view of wood-treating plant, showing at the left a horizontal cylinder for treating ties and timber, at the right a vertical cylinder for treating paving blocks, with a gantry crane between them for handling cross ties and lumber, and at the extreme right a steam storage locomotive. (*b*) Rotary veneer cutting from basswood log at the plant of the Grand Rapids Veneer Works, Grand Rapids, Mich., using Coe lathe. (*c*) Typical interior of modern Grand Rapids furniture factory, showing center trucking aisle with machines located near windows. (*d*) Typical sawmill installation on the Pacific coast. (Copyright Cress Dale Photo Co., Seattle). (*e*) Interior of a Grand Rapids vapor kiln of the box type; one of a battery of 14 at the plant of the Packard Motor Car Co., Detroit.

internal strain is usually overlooked. Fig. 3 shows a typical specimen of lumber drying: the cross-section of this board shows a wet center and a dry surface. The establishment and maintenance of a proper degree of enveloping humidity is the most difficult part of the drying operation, usually not appreciated by engineers. Of the various systems on the market each has its advantages: the blower types for veneer, finishes, glued work, etc., where there is no great thickness to be dried; the condensing kiln for the very thick and green lumber where plenty of time is available and careful operation possible; the ventilating type for speed and efficiency in the average plant of the majority of lumber producers and consumers. Artificial drying for piano actions, phonograph horns, and high-grade furniture requires a more refined process than that of general lumber drying. The opportunity for research and practical investigation along these lines is very great.

Cooperage, or the making of barrels, kegs, tubs, pails and casks, is in a very primitive condition and would completely discourage any engineer who might assume the problem of developing it. In a tight barrel the staves are first baked dry in a kiln, then machined to size and then assembled in barrel form and hooped for one-third of their length. The next operation is steaming to soften and render the assembled staves pliable so that the bulge of the barrel can be produced. When the hooping operation is completed the barrels, without heads, are set over little fires to again bake them dry. This process is only typical of others as crude.

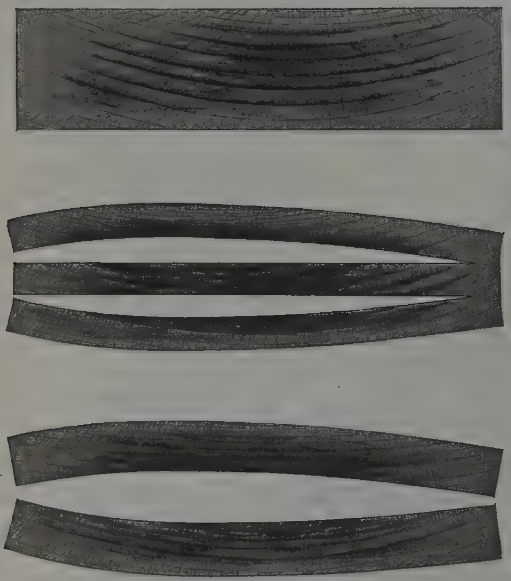


FIG. 3 CROSS-SECTIONS OF UNEVENLY DRIED BOARD WITH MORE MOISTURE IN CENTER THAN ON OUTSIDE SURFACES

The two lower sections show the effect of resawing this board and releasing the internal strain. The big problem in lumber is to dry without internal strain.

The impregnation of woods with various preservatives has received some engineering encouragement, perhaps because the creosoting of ties has been so intimately connected with railroad engineering. Very light woods used for life preservers need an "encysting" process to prevent rapid mold and rot. Woods used for insulation require similar retardents against decay. Fireproofing treatments to make wood shingles less inflammable are in the same class. Sterilizing treatments are necessary to destroy various fungus growths in warm climates, such as the blue stain in pine timbers. Woodwork to be sent to oriental countries must be made unattractive to the multitude of insect borers which attack nearly all untreated woods. The solution may be partly chemical, but it is certainly well within the broader engineering scope.

The making of wood pulp is an example of wood utilization developed through engineering skill, but it happens to be a process that is complicated and demands large production units.

The strength of timber of various species has been the subject of many tests under varying conditions, but a recognized standard compilation does not exist. The airplane has brought this subject prominently to the front, because the life of an airman or the success of his military mission would frequently depend on the reliability of wood parts. This phase of strength, recognized in only two of many uses, offers a vast field for consistent investigation and comparative study. What relation has density, or frequency of growth rings, or heart and sap wood to strength and elasticity? The authorities are few and their conclusions far from final. The tip of an airplane propeller moves at the rate of five miles, or 26,000 ft., per min. How can wood be made to endure this strain?

Wood is used in automobiles for spokes, felloes, bodies, top bows, dash boards, foot boards, running boards, battery parts, and sometimes for the all important work of distributing the weight of body and engine on the axles. Authorities vary widely as to the merit of wood and steel wheels, and as to the relative comfort and durability of wood and steel trusses from body to axles. No conclusive authority exists for intelligent guidance.

Production methods or industrial engineering are hardly developed as yet in the woodworking industry. Factory equipment and systems are largely lacking in productive efficiency. The application of production processes which have proved successful in other lines than woodwork is hardly to be regarded as more than experimental in such a new field. The average woodworker has very little regard for the production engineer at the present time. However, there are developing here and there unrelated and uncoördinated examples of scientific factory production. What better service could be rendered by engineers and engineering publications than to assist in standardizing and disseminating the best results? A few firms are specializing in this work, but there is available no supply of trained men from which to recruit their staffs of workers.

The public schools of this country have been struggling with the sloyd or so-called manual training in woodworking branches for many years, but where is an institution that produces even the rudiments of a woodworking training? Even the Massachusetts Institute of Technology has next to nothing to offer except patternwork and tests on strength of lumber. The forestry schools, notably the New York State College of Forestry at Syracuse, are making a beginning, but employers do not realize the need of sending their men for even short courses. Recent attempts to draw from the whole state of New York for a six weeks' course in kiln engineering resulted in less than a dozen pupils for the second year's trial, and the first year brought even less response, which did not warrant carrying the course through.

The foregoing is far from exhausting the list of the many opportunities in woodworking for suitably trained engineers. The demands for recreation and amusement require golf clubs, ball bats, billiard equipment, bowling-alley equipment, dominoes, checkers, chessmen, and gun stocks, all of which call for manufacturing efficiency in diverse lines.

The domestic equipment of the average home embraces matches, toothpicks, clothespins, cutlery handles, churns, caloric cookers, hollow woodenware, rolling pins, potato mashers, broom handles skewers, and many other articles. Each is made in sufficient quantity to occupy many factories and employ hundreds and often thousands of workmen.

Airplanes and automobiles are not the only vehicles of transportation that use wood in large measure. There are wagons, buggies, freight cars, passenger cars, boats and ships in which strength and durability are absolutely essential in material, design and fabrication.

The field for the engineer in woodworking is almost unlimited, but the development of such a new and untried line will take education, patience and adaptability on the part of all who are vitally interested in the trades that employ so large a proportion of our citizens.

An Investigation of Compressed-Spruce Pulleys

By GEORGE S. WILSON[1], SEATTLE, WASH.

With the view of determining the practicability of manufacturing pulleys from native spruce, a series of tests was conducted in the Mechanical Engineering Laboratories of the University of Washington. These tests extended over a period of nine months from July 1, 1919, to April 1, 1920, and the investigation included the following:

a Determination of some of the factors influencing the carrying capacity of compressed-spruce pulleys

b A comparison of compressed-spruce pulleys with other commercial types.

The work was undertaken at the request of Watts & Walsh, of Tacoma, Wash., manufacturers of compressed-spruce power-transmission and conveying equipment, to whom much credit is due for assistance given in conducting the tests.

The tests were made with single-ply leather belting 4 in. wide by 0.225 in. thick or 0.9 sq. in. in cross-section. The pulleys were nominally 18 in. in diameter and 6 in. face. A constant speed of 2000 ft. per min. was maintained.

In general, the tests consisted of sets of observations on belt slips (slip includes creep) at different initial belt tensions and varying brake loads. Five different initial tensions were used in each set (37½, 75, 112½, 150 and 187½ lb per sq. in. of belt section), and the load varied from a minimum to the maximum that the belt would carry or the capacity of the driving motor would allow.

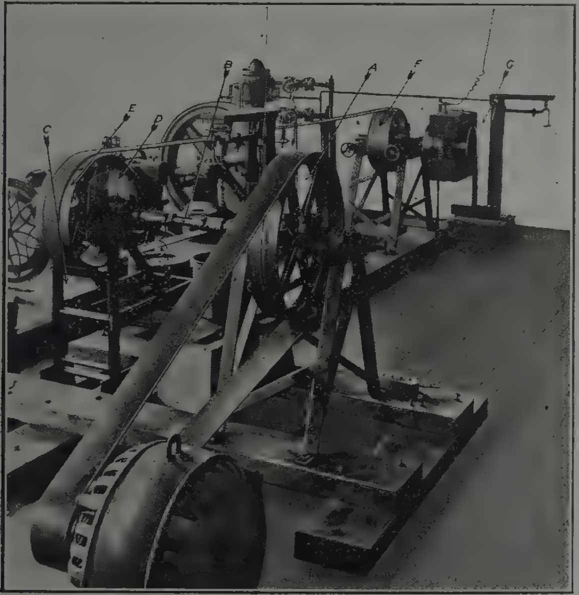


Fig. 1 Machine Used in Pulley Tests at University of Washington

The machine used in the tests was built for the Mechanical Engineering Department of the University of Washington. Fig. 1 shows the general arrangement, *A* being the driving pulley, *B* a universal coupling, *C* the tension-weighing device, *D* the arc-of-contact meter, *E* the driving test pulley, *F* the driven test pulley, and *G* the Prony brake and tension-adjusting device.

The slip meter used consists of two cams, on the driving and driven shafts, respectively, each of which makes contact with a spring brush once each revolution. When the cams are in phase an electric circuit is closed through the contacts and a lamp flashes once each revolution. As the driven shaft lags behind the driving shaft, however, the cams gradually get out of phase and the light goes out until the driven shaft has dropped one full turn behind the driving shaft, when it starts flashing again. To determine the slip a continuous counter, operated by the driving shaft, was started at the first light flash and allowed to run until the light had died out; when the light again began to flash, the counter was stopped. The reading obtained was the number of revolutions made by the driving shaft for the loss of one revolution of the driven shaft.

After considerable preliminary experimenting it was decided that a 50 per cent end-grain spruce pulley built with about ¼-in. laminations and compressed under 250 tons total pressure, with the face properly crowned, smoothly finished and coated with high-grade shellac, should be used in a comparative series of tests with steel, split wood, paper and cast-iron pulleys. Fig. 2 shows the pulley selected.

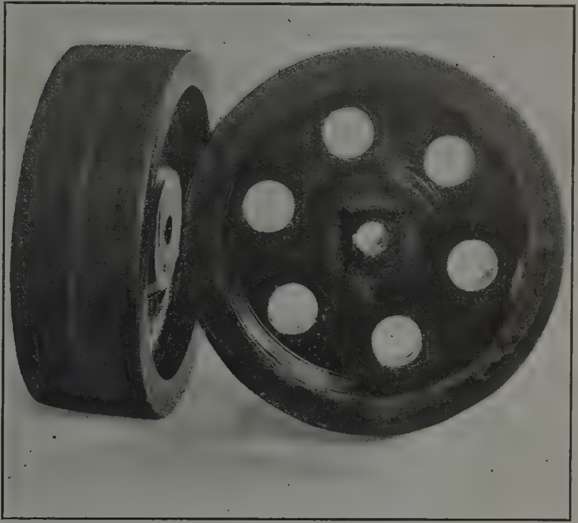


Fig. 2 Compressed-Spruce Pulley Employed in Tests (¼-in. laminations compressed under 250 tons total pressure)

In the comparative tests the driving motor used was not sufficiently powerful to load the pulleys to their maximum capacity, but the curves in Figs. 3 and 4 show the results within the load limits. It will be noticed that for belt slip below 2 per cent the variation in the capacity of the different pulleys is small, with the exception of the cast-iron pulleys, which have the lowest capacity of any of those tested.

TABLE 1 HORSEPOWER CAPACITIES OF PULLEYS PER INCH WIDTH OF BELT

Pulley	Slip, per cent			Comparative transmitting capacity at 2 per cent slip
	1	1.5	2	
Cast iron	0.58	0.69	0.74	100.0
Steel	0.71	0.78	0.81	109.4
Wood, split	0.63	0.77	0.82	110.8
Paper	0.62	0.76	0.83	112.1
Compressed spruce	0.76	0.81	0.84	113.5

Beyond the 2 per cent slip range the variation in capacity is probably greater. In all cases the capacity will be affected by the amount of crown on the pulley, the finish of the pulley face, and the condition of the belt and belt lacing.

While Figs. 3 and 4 furnish the engineer a definite measure

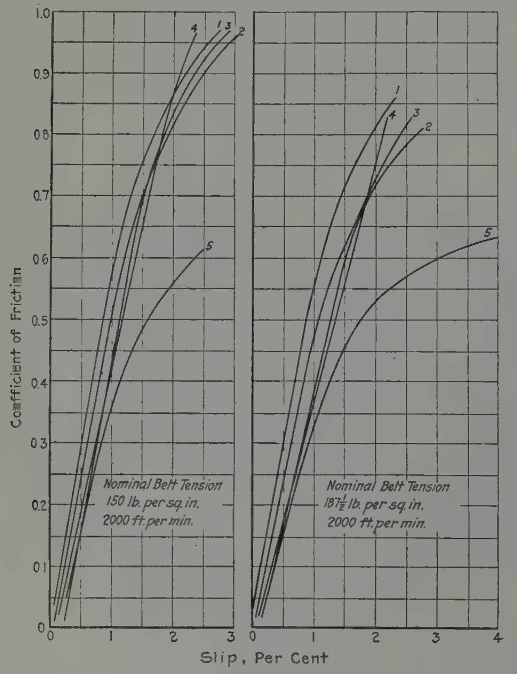
Abstract of a paper presented at a meeting of the Washington State Section of The American Society of Mechanical Engineers, Seattle, Wash., April 19, 1920.

[1] Associate Professor of Mechanical Engineering, University of Washington. Mem. Am. Soc. M. E.

of pulley capacities, Table 1, which gives the horsepower per inch width of belt, will probably better serve the needs of the average pulley user. This table is calculated from Nagle's formula, assuming a belt contact of 180 deg., a belt thickness of 0.225 in., a belt speed of 2000 ft. per min. and a stress of 200 lb. per sq. in. of belt section; values of the coefficient of friction were taken from Fig. 4.

Since the weights of pulleys may be a factor in some installations, the pulleys tested (all 18 in. diam. by 6 in. face) were weighed, with the following results:

Pulley ...	Cast Iron	Steel	Wood, Split	Paper	Compressed Spruce
Weight, lb.	65	40	21.5	41.5	22



FIGS. 3 AND 4 FRICTION-SLIP RELATIONS FOR VARIOUS TYPES OF PULLEYS

Pulleys: 1, Compressed Spruce; 2 Steel; 3, Wood, split; 4, Paper; 5, Cast Iron. Belt speed, 2000 ft. per min.

Table 1 and the foregoing weights show that the compressed-spruce pulleys as now developed are at least as serviceable as any of the ordinary commercial types.

STANDARDIZATION OF FIRE-HOSE COUPLINGS

THE state-wide movements in several states of the Middle West toward the adoption of National Fire Hose Couplings, reveal the fact that this problem of standardization is fast becoming one of nation-wide importance. Failure to recognize it as such in the past has resulted in enormous fire losses which have been due in no small measure to the lack of uniformity in fire-hose couplings in adjacent cities and towns.

The first real movement for standardization may be said to date back to the great Boston fire of 1872. Following this conflagration several of the near-by cities, profiting by the experience, adopted the Roxbury thread coupling which was the Boston Standard at that time. Later New York City adopted a thread which became the local standard through general adoption by most of the New Jersey and New York State municipalities within a radius of from 50 to 75 miles. Local standards have been adopted in a number of places which have given a feeling of security and complacency. Experience has shown, however, that such an attitude is not entirely justified because of the fact that outlying towns are little better off than if there were no standards at all.

The first organized effort toward the adoption of a universal standard thread was made by the International Association of Fire Engineers during the period 1873-1883. It was not, however, until a Committee on Hose Couplings and Hydrant Fittings of the National Fire Protection Association was appointed in 1905 that the work was effectively started. Through the efforts of this committee the couplings known as the National Standard promptly received unqualified approval and adoption by all of the leading organizations concerned with fire protection and by many municipal fire departments. Coincidentally The American Society of Mechanical Engineers appointed a sub-committee on fire protection whose report (Transactions No. 1398, Volume XXV, 1913) describes the methods by means of which the standards were adopted, the specifications for hose couplings, and the methods for converting non-standard couplings.

In December 1919 an illustrated pamphlet, Standardization for Fire Hose Couplings and Fittings, containing an extended treatment of the subject of this standardization, and a complete description of the resizing or standardization tools, was issued by the National Board of Fire Underwriters of New York City. Upward of 12,000 copies of this pamphlet have been distributed among water works and fire-department officials, state fire marshals, insurance commissioners and other interested organizations. This pamphlet, copies of which are still available, contains a description of a set of tools devised for the purpose of reforming to standard size, threads which are slightly different from standard.

There are about 8000 cities or towns in the United States and Canada that have fire-hose fittings in service. Statistics show that 15 per cent of them have National Standard thread couplings; 70 per cent have couplings that may be resized and made standard, and the remaining 15 per cent are either using couplings which have six threads to the inch or one of the various types of snap or clutch couplings.

Because of the progress in adopting the National Standard Coupling made by the state of Indiana, this state has been recognized as a pioneer in the field of state-wide adoption. As a result of the satisfactory demonstration of a set of resizing or standardization tools on the undersized fittings of the town of Thornton, the oversized fittings of Lebanon and a variety of threads in the headquarters of the Indiana Fire Department, the organized movement for state-wide adoption was initiated. According to the latest statistics, 13.5 per cent of Indiana towns are already using standard threads, and 70 per cent have threads which may readily be made standard, but in the case of the remaining 16.5 per cent it is believed that the best results will be obtained through complete replacement of the fittings now in use.

It has been estimated that the above-mentioned 70 per cent of Indiana towns and cities can be completely standardized in eight months by keeping in continuous use six complete sets of resizing or standardizing tools. It can readily be seen that the cost of the entire work is small as compared to the advantages to be derived from the elimination of confusion and delays due to the existing misfits.

Similar state-wide standardization movements have been instituted in Kentucky, West Virginia, Minnesota, Michigan and Illinois, and the added interest made manifest at recent demonstrations of the resizing tools and the number of inquiries received at the office of the National Board of Fire Underwriters in New York, clearly indicate that this long-desired movement toward standardization and conservation will, in the near future, attain nation-wide magnitude and importance.

The American Society of Mechanical Engineers has supported this movement from its inception and, as a body, is much interested in the recent strides toward its general adoption. Members who reside in localities where standardization movements have not already been initiated, are urged to take upon themselves the matter of arousing their respective communities to the importance of the subject.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

- Stevens Super-Power Station
- General Electric Design of a Super-Power Station
- Economics of Power Generation
- Report of Committee on Prime Movers of the National Electric Light Association
- Explosion Gaps in Large Power Stations
- Steam Turbine, Double-Cylinder Extraction and Low-Pressure
- Steam Turbine, Power-Producing, Pressure-Reducing
- Super-Power Zones in New England
- High-Pressure, High Superheat Steam Plant
- Power Plants, Distribution of Fuel and Water Consumption
- Balancing Turbine Rotors
- Gear Erosion
- Condenser Tube Corrosion
- High Steam Pressures
- Pulverized Fuel
- Water Purification in Power Plants
- Radiators for Aircraft
- Air-Duct Design (Chart)
- Viscosity of Oil Blends, Saybolt
- Metal Substitution in Germany During War
- Coke Breeze on Underfeed Stokers
- Heavy-Oil Engines, Fuel Injection
- Automobile Engines, Limits of Slow Running in
- Graphite Lubricants
- Cams for Radial and Rotary Engines
- Bicycle Chains
- Rolled Products of 99 per cent Nickel
- Bearings, Radio-Thrust, Load Characteristics
- Locomobile, Compound, with Superheater

The Stevens Super-Power Central Station

OF the many remarkable changes in the life of the people and in the industries of the world during the past 30 or 40 years, none has been more profound than the rapid increase in the consumption of mechanical power. A man of two-score years ago consumed very little mechanical power. His food and supplies to a large extent came from nearby neighborhoods, brought by horse-drawn vehicles. He did comparatively little traveling, his home was lighted by kerosene lamps, and in most towns his water was pumped by hand from wells or drawn from springs. Many hand-made articles were in daily use and those which were produced in factories involved hand operations which have since been superseded by machine operations requiring the use of power.

The man of today, however, at every step is directly or indirectly a large consumer of power, from the moment he gets up and turns on the water for his bath to the time when on retiring he turns off the light and thus relieves the load on the lighting plant of his own town. Not only has there been a great increase in the multiplicity and variety of manufactured articles, but there has been a corresponding growth in transportation and illumination. Raw materials, food supplies and produce are brought from all parts of the world, and manufactured products are as widely distributed. The great systems of electric transportation and electric illumination have come in, taking power from immense central stations, and the automobile is made by the million in plants with thousands of power-driven machine tools.

It is obvious that with this enormous increase in power requirements some means must be provided for generating the power on a scale commensurate with the demand and adequate to the requirements of the future. This means larger stations, and the tendency toward bigger units is strengthened by the growing cost of fuel and labor, as it is a well-established fact that the larger units are more economical in both regards than the smaller ones.

Nevertheless the concentration of very large volumes of power generation in one unit involves certain not inconsiderable difficulties and dangers. Items that would be comparatively small in the central station of moderate size become very big indeed in the giant installations, such as the proposed Stevens super-power central station, and furthermore, like the proverbial carrying of all the eggs in one basket, it involves great dangers in the way that a breakdown of a single big super-power central station would affect the life of the community to a far greater extent than a similar breakdown of only one of several scattered and possibly interconnected units.

It is obvious that on one hand there is a real field for the very large power-generating plants. On the other hand, the design of such plants involves a superlative degree of skill and care both to secure the highest economies in operation possible for this type of construction and to insure the degree of reliability consistent with the vital place which the super-power central station is to play in the life of the community which it serves.

From this point of view the two articles by John A. Stevens, Mem. Am. Soc. M. E., in *Power* (May 25 and June 1, 1920) are worth the most careful consideration.

The basic features of the Stevens plant are the use of a definite large size of unit, namely, 30,000 kw.; the separation of all boiler houses from their turbine rooms by "explosion gaps," the separation of the turbine rooms from each other by explosion walls; and further, the use of a particular type of turbine as the driving unit.

Thirty thousand kilowatts has been selected as the standard size of the unit as being the size within the zone of maximum economy in steam-turbine engineering practice and also as being about the limit of size that can be supplied with four sections of boilers served with one central stack. This size of unit, of which about eight would be used in the station, determines the general arrangement of the station.

The description of the station may be well started with that of the boiler plant. It is proposed to use Stevens-Pratt boilers, of 1716 hp. normal rating, arranged in units of four with one central stack which is from 300 to 350 ft. high in order to discharge the gases and dust at high altitudes. As shown in Fig. 1, the boilers will be installed in practically an independent building with an outdoor passageway between it and the turbine room. The reason for this is safety. Notwithstanding the high degree of skill in the design of large modern boilers, explosions and minor accidents, such as tube failures, are to be expected. To provide for such cases and also to guard against the results of short-circuits in generators an "explosion gap" (so-called) is left between the boiler room and the turbine room, localizing the damage to the plant where the accident occurred.

The same regard for safety has led to the division of each group of turbine rooms themselves by protecting walls which reach to the crane height. With such a wall 25 or 30 ft. high there is some chance for the operators to escape in the case of bursting of steam mains or fittings unless the explosion is very disastrous. Still further, each 60,000-kw. capacity power house should be separated from the next unit of the same size by a space of 20 to 40 ft. in the clear. See Fig. 2.

As regards heating the air which supports the combustion, a very high temperature is not advocated, but only a moderate degree of heat, steam being extracted from high-pressure stages to supply the air heaters.

On the firing floors stands are provided for the main motor-actuated stop valves, which may be controlled electrically from the switch house or from any part of the plant. Also, a master valve at or near the boiler plants, with remote motor control, is desirable, to be used in the event of serious disaster in the turbine room.

For economizers a type is recommended representing a combination of cast-iron sections and steel sections through which the water is pumped in series.

Among features not usual in ordinary plants but suggested for the Stevens super-power station may be mentioned periscopes for observation of the furnaces and for reading the water-gage-glass levels, a remote-control whistle valve, and even a wireless apparatus with aerials connected to the stacks, also searchlights above the elevators for protection of the station in case of disturbances. Telephones are provided at all important points, for example, at or near the boiler-drum manholes, near the fans, etc., so that any accident or defect can be reported instantly. Above the umbrella on the stack and at the base of the umbrella, pipes are provided to wash off the dust that may collect on the plate-glass roof, while underneath this roof a shade is installed on rollers so that on a hot summer day the operating room may be shaded and made comfortable.

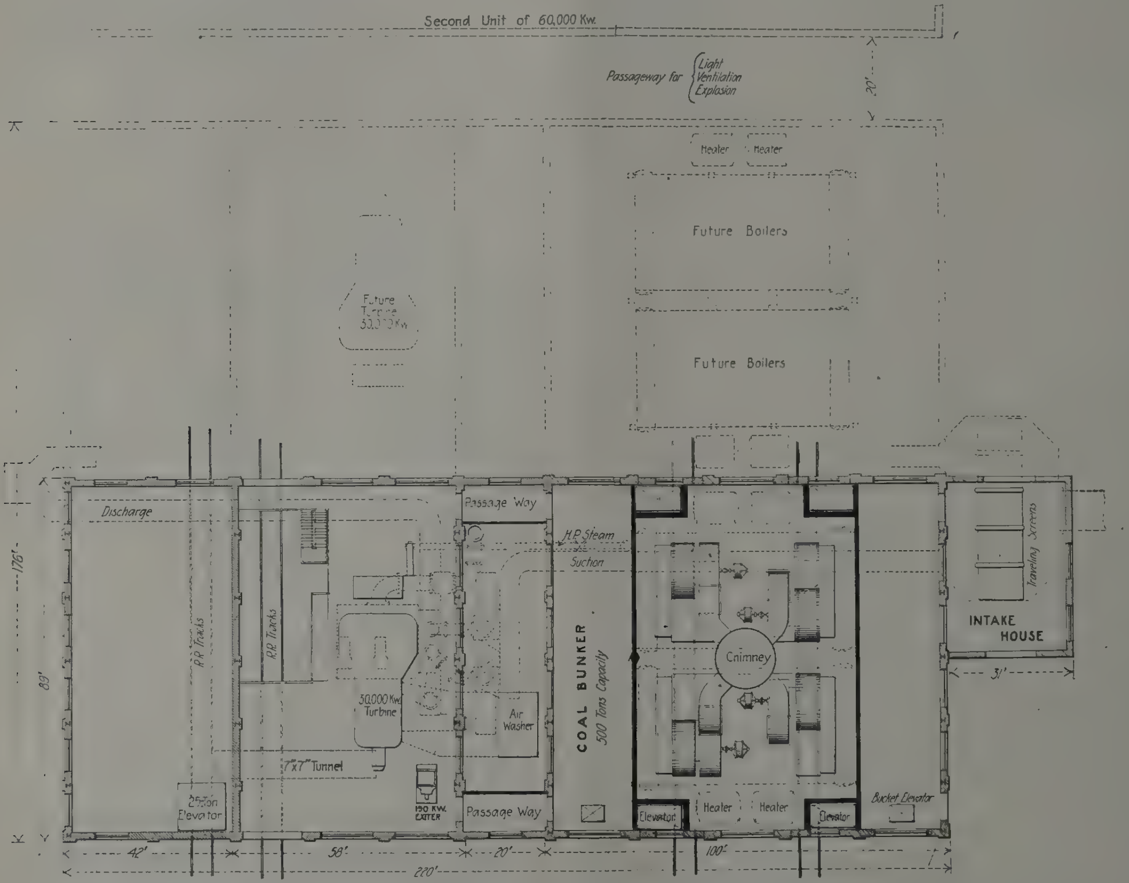


FIG. 1 PLAN VIEW OF A THIRTY THOUSAND-KILOWATT INSTALLATION SHOWING FOUR 1716-HP. STEVENS-PRATT BOILERS AND ONE 30,000-KW. TURBINE. DOTTED LINES INDICATE DUPLICATE INSTALLATION, MAKING A TOTAL OF 60,000 KW. FOR A COMPLETE UNIT

As a precaution against damage to the generating units a check valve made of heavy plate is placed at the warm-air discharge to the stoker fan, so that in the event of a minor explosion in the tube area of the boilers the dust and soot will not be blown into the main turbine generator.

No matter how carefully and skillfully a plant of the size of the Stevens super-power central station may be designed or built, from the commercial point of view its ultimate success will be determined by the appropriateness of the selection of the power-generating units. From this point of view it is of interest to note that in the present instance a rather novel turbine arrangement is proposed for use, which the author terms a double-cylinder extraction and low-pressure turbine.

In addition to the power generated by super-stations, considerable amounts of steam have to be used either for district heating wherever there is a field for it or for manufacturing and heating processes. Until recently, however, no turbines were built for operating non-condensing, or against a back pressure of over 60 lb., though in some instances, as, for example, in the rubber industry, considerably higher pressures (80, 90 or even 100 lb.) are desired; and these are what the double-cylinder extraction and low-pressure turbine is intended to supply.

As shown in Fig. 3, such a turbine consists of high-pressure and low-pressure units mounted on one shaft with, say, a 10,000-kw. generator. This machine is said to operate automatically with steam extracted from zero gage to, say, 80 lb. pressure, or from 0 to 244,000 lb. extracted at a predetermined pressure. It will operate entirely condensing with only a slightly reduced economy from that of a standard machine, and it will operate also for any intermediate extraction of steam or generation of power. At the same time large amounts of steam may be admitted to the low-pressure casings in the way of returns from vulcanizing machinery, which should be put through regenerators or separators at 1 to 2 lb. pressure for the precipitation of the acids. The control of this machine is from the sustained or maintained pressure in the steam line to the manufacturing systems. In other words, the machine is controlled from its by-product rather than from its electrical end; but at the same time, if more service is demanded from the electrical end than the proportionate

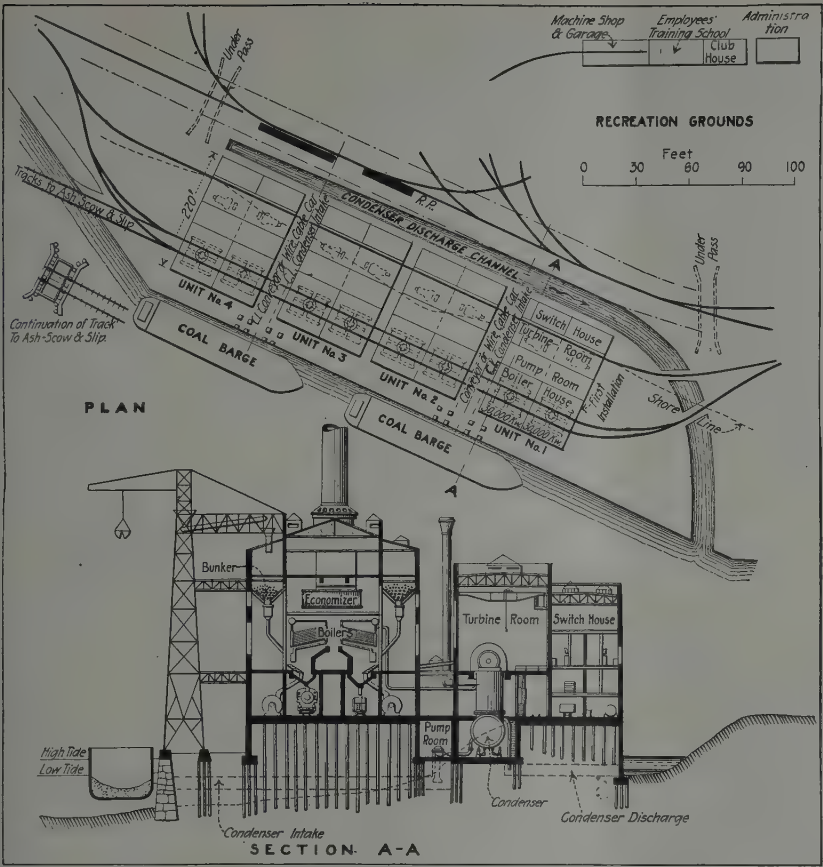


FIG. 2 PLAN AND ELEVATION OF A TWO HUNDRED AND FORTY THOUSAND-KILOWATT SUPER STATION

Note the explosion gaps between each 60,000-kw. unit.

amount of steam passing through to the manufacturing process would admit, the automatic valve mechanism will open to the low-pressure or condensing turbine the necessary amount of steam to follow the electrical demands.

As regards economies, it is stated that a machine of this type

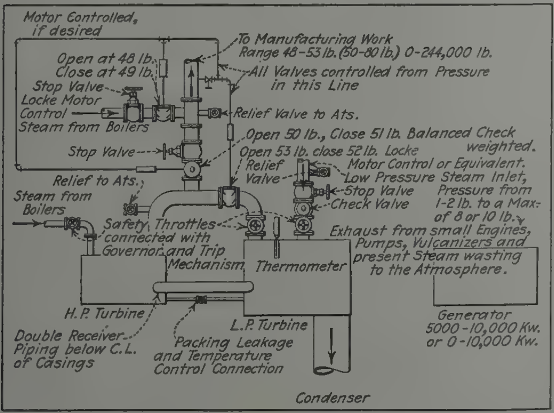

Motor Controlled, if desired
To Manufacturing Work Range 48-53 lb. (50-80 lb.) 0-244,000 lb.
Open at 48 lb.
Close at 49 lb.
All Valves controlled from Pressure in this Line
Stop Valve
Locke Motor Control
Steam from Boilers
Relief Valve to Ats.
Open 50 lb., Close 51 lb. Balanced Check weighted.
Open 53 lb. close 52 lb. Locke Motor Control or Equivalent.
Stop Valve
Relief Valve
Low Pressure Steam Inlet, Pressure from 1-2 lb. to a Max. of 8 or 10 lb.
Relief to Ats.
Stop Valve
Check Valve
Steam from Boilers
Safety Throttles connected with Governor and Trip Mechanism
Exhaust from small Engines, Pumps, Vulcanizers and present Steam wasting to the Atmosphere.
Thermometer
H.P. Turbine
L.P. Turbine
Generator 5000-10,000 Kw. or 0-10,000 Kw.
Double Receiver Piping below C.L. of Casings
Packing Leakage and Temperature Control Connection
Condenser

FIG. 3 DIAGRAMMATIC SKETCH OF DOUBLE CYLINDER EXTRACTION AND LOW-PRESSURE TURBINE

may be installed to keep the entire output when running non-condensing or part non-condensing and part condensing, at a rate of 7 lb. of steam or less per kilowatt-hour at the generator leads chargeable to power in kilowatts.

For smaller units the author recommends a type of turbine which he terms a power-producing, pressure-reducing turbine (Fig. 4). This turbine is so valved and arranged that it will automatically float on the line and deliver quantities of steam in proportion to the demand, giving a proportionate amount of by-product power. Furthermore, as these turbines are manufactured in small units they may be located at a distance from the boiler plant, which will do away with the necessity of running large and expensive low-pressure mains throughout the plant from the central station.

Summing up, Mr. Stevens states that in his opinion the power plant of the future will be along the basic lines presented in his articles, and he suggests that power contracts be made with the permission to manufacture what power is desired by by-product turbines—that is, by-product to power production—and by such station designs as he has shown in the articles. Continuing, he says:

> Locating these super-power stations in large industrial communities would enormously reduce the amount of coal necessary to handle the power of such communities, for the coal consumed per unit in the super-stations, broadly speaking, is about one-half that of the isolated plant, and by making use of the by-product turbines for manufacturing and heating steam, enormous further reductions in the use of coal are made, to say nothing of a relay power at the customer's plant or at least a part relay to the purchased power.
>
> These large stations require such vast amounts of condensing water that they can be located only on such rivers as the Connecticut or Merrimack, or at shore ports on rivers, lakes or oceans, where the intake canal and discharge canal, or conduit, from the condensers should be 1000 ft. or more apart. Of course, the question of currents, tidal effects and many other conditions enter into this problem, but this statement is made for guidance of designers in planning a station location. Furthermore, it would not be advisable to start any super-station where the ultimate development possible would be less than 100,000 kw. It would be better not to locate in any position where an ultimate development of 240,000 kw. or 300,000 kw. was not possible. This, however, would be controlled

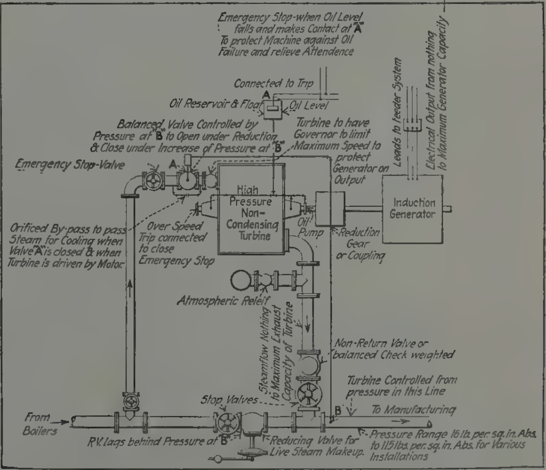

Emergency Stop-when Oil Level falls and makes Contact at "A" To protect Machine against Oil Failure and relieve Attendence
Connected to Trip
A
Oil Reservoir & Float
Oil Level
Leads to feeder System
Electrical Output from nothing to Maximum Generator Capacity
Balanced Valve Controlled by Pressure at "B" to Open under Reduction & Close under Increase of Pressure at "B"
Turbine to have Governor to limit Maximum Speed to protect Generator on Output
Emergency Stop-Valve
A
High Pressure Non-Condensing Turbine
Induction Generator
Orificed By-pass to pass Steam for Cooling when Valve "A" is closed & when Turbine is driven by Motor.
Over Speed Trip connected to close Emergency Stop
Oil Pump
Reduction Gear or Coupling
Atmospheric Releif
Steamflow Nothing to Maximum Exhaust Capacity of Turbine
Non-Return Valve or balanced Check weighted
Turbine Controlled from pressure in this Line
Stop Valves
B
To Manufacturing
From Boilers
R.V. lags behind Pressure at "B"
Reducing Valve for Live Steam Makeup.
Pressure Range 16 lb. per sq. in. Abs. to 115 lbs. per sq. in. Abs. for Various Installations

FIG. 4 DIAGRAMMATIC SKETCH OF TURBO-GENERATOR ARRANGED TO OPERATE AS A POWER-PRODUCING, PRESSURE-REDUCING TURBINE

largely by the cost of transmission lines, franchises, money values, and innumerable other conditions that enter into a project of this size.

When otherwise practicable, it will be well so to choose locations for central stations that later full advantage may be taken of economies to be brought about by the recovery and utilization of distillates and other chemical products from coal. This is a matter at present little thought of but likely to be of increasing importance for the future.

To illustrate further what prominent engineers of the country think of the possibilities of the great super-power stations of the future, Mr. Stevens refers to the super-power plan presented at the Midwinter Convention of the A. I. E. E., New York, February 19, 1920. The zone embraced by this plan (see Fig 5) comprises the area between Boston and Washington and extends inland from the coast 100 to 150 miles. The transmission lines from the hard and soft coal fields, Niagara Falls, Cedar Rapids on the St. Lawrence, and from the Maine hydroelectric plants which Mr. Stevens suggests are shown in Fig. 6. He says:

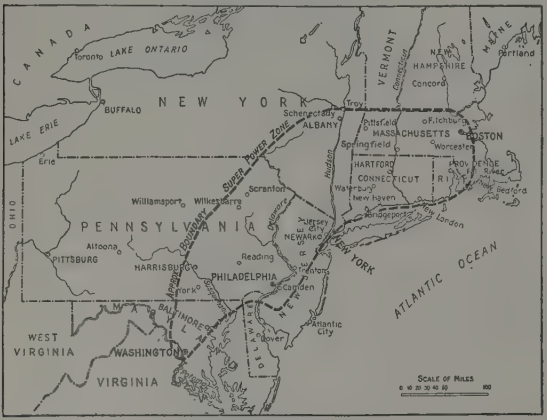


FIG. 5 MAP SHOWING APPROXIMATE SUPER-POWER ZONE

> From investigations and research I have found that there is a 300,000-kw. load, not including the steam-railroad electrification, within a radius of fifty miles from Newburyport or Beverly, Mass., which could be tied in with the great water-power developments at Manchester, N. H., Lowell and Lawrence, Mass., and with the great development and proposed developments of the Edison Company, of Boston, Mass., the conservation in this power zone alone amounts to about 500,000 long tons of coal per year, conservatively speaking, with all the attendant advantages in the conservation of coal, money and men. The project considers the use of the river banks and railroad rights-of-way for transmission lines, and placing a station of that kind in the northeastern range of the proposed super-power zone illustrated by Fig. 5 would reinforce in a splendid manner the loop transmission line suggested.
>
> Further, there is a vast amount of coal in Nova Scotia which, if used as pulverized fuel, would make two methods of shipment to this point by water—Nova Scotia coal and coal from the Virginia fields. This would greatly relieve the congested freight situation.
>
> A cross-tie in this loop in New England and somewhat paralleling the Connecticut River and its hydroelectric and large steam developments is suggested. This would further substantiate and augment the eastern part of the super-power zone loop in New England and would also further relay the great power demands of New York City and vicinity. There are other untold resources in New England for such a project as has been outlined herein.
>
> The time will come when no company or individual will be allowed to operate any plant at a thermal efficiency of less than a predetermined percentage; neither will any company be allowed to operate any turbines or equivalent machinery condensing when they could be operated non-condensing and the exhaust steam used in heating and manufacturing, or when purchased power from a large super-station can be advantageously made available. In other words, as coal and oil, in fact, all known fuels, are non-renewable, natural resources, the general public will be forced to use the utmost care in their consumption. (*Power*, vol. 51, no. 21, May 25, 1920, pp. 832-836, 3 figs; and no. 22, June 1, pp. 879-8844, 11 figs.)

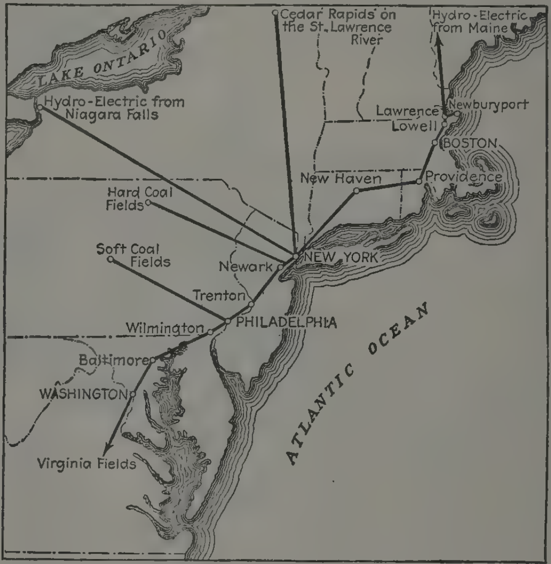


FIG. 6 SUGGESTED POWER-TRANSMISSION LINES FOR SUPER-POWER ZONE

General Electric Design of a Super-Power Station

THE high cost of fuel today and the prospect that it may go still higher in the future have given a powerful impetus toward the development of central-station design in which coal will be used with the greatest economy.

This tendency has been materially assisted by the rapidly growing demand for power. Both of these factors have created a situation where, in many instances, it becomes possible to build power plants of practically any size that will permit their economical operation, the question of getting rid of superfluous power being practically absent through the fact that there is no superfluous power available today and very little prospect of there being any in the near future.

The design described by H. Goodwin, Jr., and A. R. Smith was developed for a particular condition where some of the fundamental considerations were high fuel cost, moderately good load factor, extreme river floods and high-voltage underground distribution. It contains, however, features of great interest and capable of general application. Some of the apparatus shown, particularly boilers, economizers and preheaters, are only proposed designs.

The idea underlying the entire design of the proposed super-power station is that great economy can be obtained from large-capacity generating units operating at high steam pressure, especially when a number of these are located in one station.

In the present instance, a steam pressure of 350 lb. and superheat of 350 deg. fahr. are proposed to be used, which means that both the boilers and the turbines have to be adapted to comparatively new conditions.

The boilers (Figs. 1 and 2) will have a rating of some 1600 hp., or 16,000 sq. ft. of heating surface, and will have the two banks of tubes separated with the superheater in between. The reasons for this arrangement are, first, to permit using a two-pass boiler and still keep the economizers on the main floor, which means a greater number of tubes in height; and second, to get a high amount of superheat without an excessive amount of superheater surface.

The high pressures and superheats employed make it necessary to simplify the steam piping as much as possible so as to make the entire piping system more flexible and avoid accidents. Hence there are no steam headers in the general sense of the word, but there is a transfer header for equalizing pressures and transferring steam between boiler rooms. The steam piping is also materially simplified by the fact that there are no steam-driven auxiliaries except the few house or auxiliary turbines, of which more will be said later.

The economizers will be of wrought-iron tube construction with headers inclined with relation to the tubes. They will be cleaned with steam soot blowers, and it is anticipated that there will be no moist soot deposit, because the water entering the economizers will first be heated to 150 deg. or 160 deg. with exhaust steam, this bringing the temperature well above the dewpoint of the gases.

The flow of water in both the vertical tubes and the headers is of the thermo-siphon type, with the flow of the gases and water in the economizers in countercurrent.

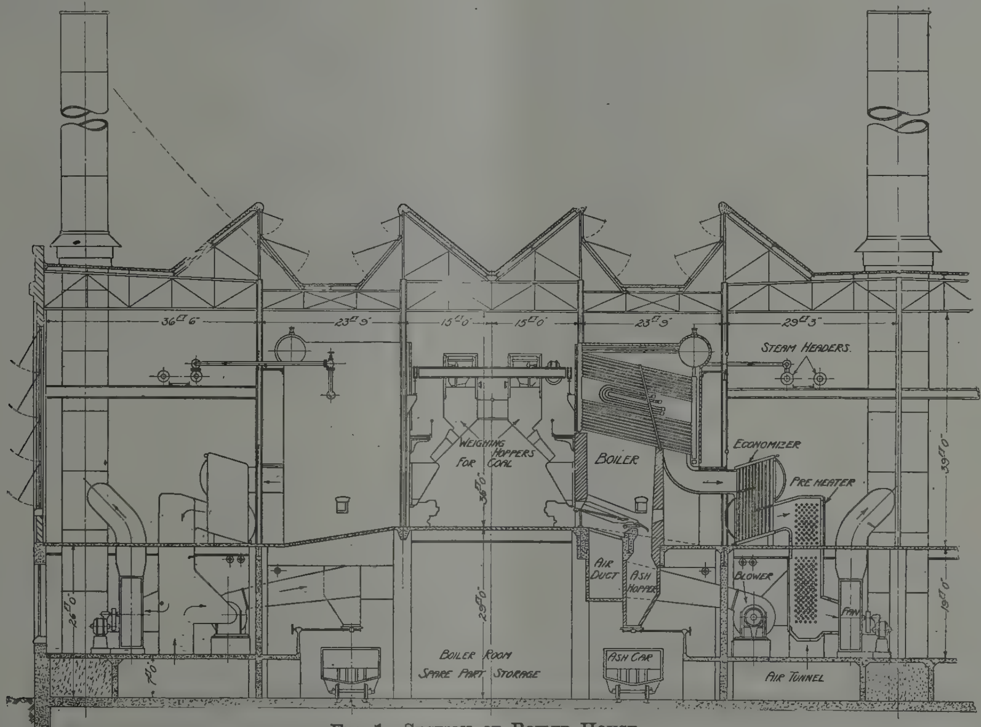


Fig. 1 Section of Boiler House

The air going to the boilers comes through a tunnel (Figs. 1 and 2) from the turbo-generators, which means that it is preheated. In addition to this, air may pass through heating tubes in preheaters divided into two units per boiler, the arrangement being such that the boilers nearest to the turbine room will burn the heated air discharged from the generators, whereas the boilers at the far end will burn the air from outside. In this connection a remark is made to the effect that it is believed that preheaters are perfectly practicable for use in stationary plants and can be made to show a good return on the investment if the cost of coal is at all high.

The use of economizers and preheaters makes induced draft unavoidable in view of the increased draft losses and the low temperature of gas entering the stacks. The draft fans might be of the ordinary belt type, or possibly of the multi-vane type, as the temperature is low and the pressure comparatively high. The induction type of stack employing high-pressure blowers may be substituted and, in general, provision should be made for the case of failure of fans.

The very high steam temperature involved in the present design makes it practically impossible to use any small steam-driven auxiliaries, such as boiler-feed pumps, etc. On the other hand, the auxiliaries, especially feedwater pumps, should be of the great possible reliability, which means that it would not be advisable to drive them electrically from the main buses. The installation of low-pressure boilers to operate the boiler-feed pumps would not be advisable either.

In order to meet these conditions it has been decided to use one 2500-kw. auxiliary or house turbine for each pair of main turbines. Such a unit can be very well adapted to the steam conditions contemplated, and will have sufficient capacity to supply all auxiliaries through a separate busbar.

As regards condensers, the main condensers will be of standard design. The house turbines will each be provided with a low jet condenser which will normally produce about 15 in. of vacuum. The circulating water for this condenser is the condensate from the main units, in addition to which some of this water may be recirculated.

In a plant of the proposed size, the question of coal- and ash-handling equipment becomes of great importance. As regards the latter, it is proposed to dispense with all kinds of ash-conveyors and instead provide under each boiler ash hoppers of such capacity as to contain 12 or 24 hours' storage, so that ashes need to be removed only once or twice during the day, the ash hoppers emptying directly into standard railroad cars.

The coal-handling equipment has been designed so as to have the bulk of the coal unloaded from barges by means of traveling crane towers at the dock and transported by two belt conveyors directly to the four receiving hoppers and crushers. From the receiving hopper the coal is delivered directly to the outside storage or through a crusher and skip hoist to the overhead outside beams.

The duplicate belt conveyors provide a large coal-handling capacity when needed, and also act as a reserve in case one conveyor should break down. All belts are dead-ended and there are no traveling trippers.

The intention is that one operator located in a control cab

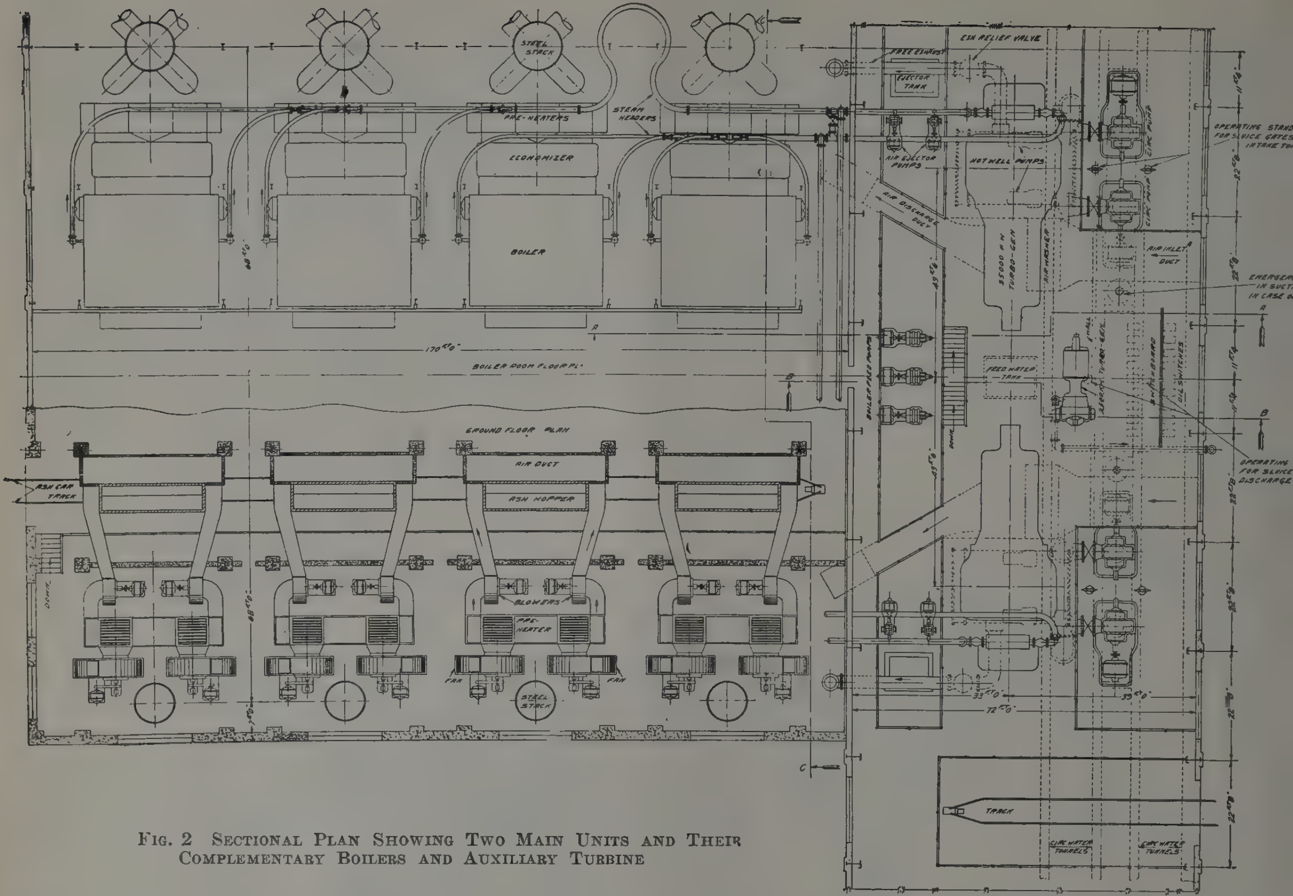


FIG. 2 SECTIONAL PLAN SHOWING TWO MAIN UNITS AND THEIR COMPLEMENTARY BOILERS AND AUXILIARY TURBINE

above each receiving hopper will operate the revolving gantry crane, the crusher, the skip hoist, etc. Another operator will be located on each electrically operated larry to transport and weigh the coal from the overhead bins to each boiler. The emergency coal storage handled by the locomotive traveling crane will be operated only when the excess coal is being stored or reclaimed.

It is proposed that there be one spare larry which can be readily run into any one of the four firing aisles to replace any defective larry. It will be observed that the revolving gantry crane reclaims the coal from the circular storage without moving the bridge; thus this method is very rapid when reclaiming coal, although in distributing the coal the bridge will have to be moved slightly from time to time, but to minimize this movement outside shoots are shown on the four sides of each receiving hopper tower. The revolving gantry cranes overlap so that coal can be transferred from one pile to another, and, furthermore, the design shown can be partially built and extended from time to time without interfering with operation or without changing existing structures.

As yet no data are presented as to the character of the main driving units. It is stated, however, that the total generating power will be 245,000 kw., 300,000 kva. capacity, on 66,000-volt distribution. (*General Electric Review*, vol. 23, no. 5, May 1920, pp. 355-418, 15 figs)

Economics of Power Generation

THE growing cost of fuel and labor forces power-generating stations to keep much closer track than ever before of every item of their expenditures, with the result that some rather unsuspected relations have been discovered.

Thus, a recent analysis of the log-sheet records of a typical electric generating station in England showed that the coal consumption might be regarded as being made up of two separate items, namely, a constant quantity per shift, which in this instance was 14,560 lb., and an additional amount for every kilowatt-hour produced—in this case 2.2068 lb.

This held good not only for heavy enough loads but also for the Sunday and early-morning loads, when the station was running only at a small percentage of capacity.

The corresponding investigation with respect to the water consumption of the station showed that this also might be regarded in a similar way, namely, as a constant quantity of 60,000 lb. of water per shift plus an additional amount of 14.37 lb. for every kilowatt-hour generated, this covering, however, only the amount of water delivered to the boilers.

These results may be expressed in the form of equations—

$$C = 14{,}560 + 2.2068\,K \qquad [1]$$

$$W = 60{,}000 + 14.37\,K \qquad [2]$$

where C represents the total number of pounds of coal burned per shift, W the number of pounds of water evaporated per shift, and K the output per shift expressed in kilowatt-hours. This permits expressing either the coal consumption in terms of water evaporation or vice versa as shown by the following equations:

$$C = 5346 + 0.1536\,W \qquad [3]$$

$$W = 6.512\,C - 34{,}810 \qquad [4]$$

From Equation [1] it is evident that the greater the output the less important becomes the constant quantity of 14,560 lb.

of coal, the station tending more and more nearly to a coal consumption of 2.2068 lb. per kilowatt-hour as the load increases. This is the limiting value of coal consumption for the particular plant. As is the case with all limits, it can never be actually attained, but will be approached as the output becomes greater. The same applies to the question of steam consumption.

These equations would further indicate that within the capacity of the plant any additional load given to the station may be considered to be generated for a net expenditure of 2.2068 lb. of coal and 14.37 lb. of water per kilowatt-hour, although the average coal and water consumption, if calculated by usual methods, would be considerably greater. This determines the cost of service on extra loads, which do not necessitate any increase in wages, capital charges, or items of expenditure, except coal and water.

Equation [4] is of interest as it shows that the water evaporated per shift is 34,810 lb. less than it would be if every pound of coal evaporated 6.512 lb. of water. Obviously, the greater the output the less important becomes the constant, which has to be deducted from the weight of water evaporated and in the limit 6.512 lb. would be turned into steam for every pound of coal burned. The low value of evaporation is in this instance ascribed "entirely to the nature of the material which is sold as coal nowadays," in the words of the author, which show that the British have to contend with pretty much the same conditions as we have in this country.

An interesting application of the above equation is made to the measurement of the so-called stand-by losses, which is done in the following manner:

Referring to Equation [1], it will be seen that in the particular station under consideration, if no power at all were generated for a shift, there would nevertheless be required 14,560 lb. of coal to be burnt during this time to keep the station in a condition to take the load when required. The purpose of this amount of coal is to make good all the heat which is lost in the plant, whether by radiation, chimney losses, or condensation, and irrespective of whether the losses are in the engine room or the boiler room. Turning now to Equation [3], we see that if no water were to be evaporated during the shift, i. e., if the boiler-feed valves and junction valves were shut and only sufficient fuel were burnt to maintain the boiler house in a state to take up the load when called upon, the coal consumption would be 5346 lb. per shift. Hence this amount may be considered as equivalent to the boiler room losses, while the difference between 14,560 and 5346, which is 9214 lb., may equally be regarded as representing the engine-room losses. The writer is aware that this method of reasoning is open to criticism, but, from a considerable experience of power-plant economics, he is inclined to believe that the deductions are of practical value and possess a very large measure of truth.

The constant water loss of 60,000 lb. per shift, given in Equation [2], may seem high, but it is well in line with corresponding figures from other power stations. It must be remembered that the no-load condition in the engine room implies that the output has fallen to zero, but not that the plant is shut down. Now when it is realized that even a small turbine may have a no-load consumption with ordinary conditions of steam and vacuum, of something like 5000 lb. of steam per hour, or 40,000 lb. per shift, the total stand-by loss of 60,000 lb. of steam per shift does not appear excessive. The balance of 20,000 lb. per shift has to provide for running the turbine auxiliaries, the boiler-feed pumps, and the stoker engines as well as for leakage and condensation in the whole system. The stand-by steam has obviously to be generated by the stand-by coal, so that the evaporation at no load is found to be equal to 4.12 lb. of steam per pound of coal. If, however, we subtract the 5346 lb. of coal required to make good the boiler-room losses as deduced above, the evaporation works out to 6.512 lb. of water per pound of coal, which is what would be expected from Equation [4]. (Robt. H. Parsons, in *The Times Engineering Supplement*, vol. 16, no. 548, June 1920, p. 190).

Report of Committee on Prime Movers of the National Electric Light Association

THE following excerpts have been made from the report of the Committee on Prime Movers of the National Electric Light Association, Technical and Hydro-Electric Section, which was presented at the forty-third convention of that society, May 18-22, 1920. The report is very much in detail, comprising 130 large-size pages, and covers the following subjects, considered in the main with respect to recent developments and current practice: Steam Turbines, Condensers, Boilers and Superheaters, Economizers, Grates and Stokers, Burning Lignite, Pulverized Fuel, Coal By-Products, Fuel Oil, Coal and Ash Handling, Power-Station Auxiliaries, Boiler- and Turbine-Room Instruments, Ventilation of Station Buildings, Higher Steam Pressures, Oil Engines, Hydraulic Prime Movers, and Hydraulic Operation and Combined Operation of Hydraulic and Steam Plants. Considerable space is devoted to reports from manufacturers on improvements or changes in design in steam boilers, condensers, grates, stokers, etc. In the quotations which follow, however, attention is mainly given to new developments of a broader nature and to operating features. These quotations, also, relate only to steam plants using coal as fuel.

Steam-Turbine Development

A record of the units which have been manufactured since the last report indicate that 30,000 kw., 1,800 r.p.m., 60 cycles, and 35,000 kw., 1,500 r.p.m., 25 cycles, can be considered for the present as the maximum standard sizes of single-shaft, single-barrel units for large installations.

During the past year a considerable amount of information has been obtained from the operation of these large-sized units as well as from some of the smaller machines, and a period of adjustment and improvement in both design and construction, following the experience which has been gained, would seem to be imperative if these large-sized machines are to be brought to a requisite degree of reliability and operating efficiency.

The records of operation of single-shaft units have not by any means been satisfactory. Since the last report there have been several additional wheel failures which have occurred to units of this type and on sizes ranging from 5000 to 30,000 kw. capacity.

The General Electric Company has made a number of marked changes in the design of its large-sized turbines, the principal changes being the stiffening of the center bearing and modifications in the design of turbine disks, buckets, diaphragms and packing.

The changes in the turbine disks consists of a thickening of the disk in an attempt to reduce the possibility of injurious vibration; elimination of the weight-balancing holes, and the change in the number and location of steam-equalizing holes so as to move them well in from the rim; and changing from an even number to an odd number of holes with rounded and polished edges at the wheel surface.

The changes made in the buckets, particularly in the last stages, consist of the addition of a reinforced section, carrying it nearly to the center of the bucket so as to stiffen the construction materially. In addition, the very long buckets are reinforced by the use of a bracing strip, in order to minimize any vibration which might occur.

The changes to the diaphragms consist of replacing some of the cast-iron sections by cast-steel construction where stresses indicate this to be necessary. Additional clearance space around the diaphragm is also provided with the idea of allowing for the removal of a large part of the condensed water, which has contributed to serious erosion of the blading in certain stages. A radical departure has been made in the type of diaphragm packing. The new type differs from the earlier construction in that the stationary, inwardly projecting short teeth of the labyrinth have been changed to much longer teeth which are mounted on the revolving element. It is claimed that this improvement makes it practically impossible, when properly installed, for any rubbing to distort the shaft due to the generation of heat at the point of contact.

An analysis of the cause of the serious wheel failures during the past year has resulted in the accumulation of sufficient data to indicate that the trouble has been due in the past to a vibration of the wheel structure. This vibration, which has been described as a fluttering of the web of the wheels, in combination with the high working stresses of the material, gives rise to the formation of fatigue cracks. These cracks, which occur not only in the wheel but also in the bucket, when allowed to continue, result in a complete rupture. This action was accentuated in the disks where sharp tool marks or rough surfaces are present, or where holes for weight- or steam-balancing purposes are drilled in the wheel. Considerable investigation is still necessary, however, in connection with the subject of vibration of wheels before the full facts can be known and a proper design be forthcoming that will eliminate any danger from this source of trouble.

No marked changes have been introduced during the past year by the Westinghouse Electric & Manufacturing Company in the design of its single-cylinder units up to 30,000 kw. rating, although a number of minor improvements have been made. To meet the demand for larger capacities than 30,000 kw., the company has standardized on combinations of single-cylinder units of 20,000 to 22,000 kw. maximum rating in tandem, cross-compound and triple-cylinder arrangements.

While the combination of compound turbo-generators seems to be increasing in favor, and while test results indicate a higher thermal efficiency for such a combination as compared with single units of the same aggregate capacity, sufficient data are not at hand to show conclusively whether the practical operation of units bears out the theoretical advantages which are claimed.

Balancing Turbine Rotors

While it has been standard practice for years in large manufacturing companies to balance statically all high-speed rotating parts, it is only recently that equipment has been developed that will readily permit of correct dynamic balancing of rotating elements.

One type of machine, the Carwen static-dynamic-balancing machine, has proved very effective in the balancing of moderate-size rotating elements. The principle of operation of this machine depends upon the creation of an artificial unbalance in some of its own moving parts, which exactly counteracts the unbalance of the body to be tested. When this artificial couple or unbalance becomes the exact counterpart of the unbalance in the body being tested, the whole unit ceases to vibrate and the quantities of the unbalance are indicated on suitable dials located on the machine.

The Akimoff combined static and dynamic balancing machine, although built along somewhat different lines, has also a bedplate hinged in such a manner as to vibrate in the two planes. No compensating couple is used in this machine. Instead, a balancing clamp is attached to one end of the object to be balanced and rotates with it. The position of the clamp and the location of a sliding weight attached to the clamp are changed until the resultant of the unbalanced force is neutralized and the vibration reduced to zero.

Another device which has recently been designed and built for measuring the amplitude of the vibration of machines while in operation—called the "Vibroscope"—has given very satisfactory results. In this device the frame or vibrating part of the instrument is so arranged that it may be conveniently attached to the machine whose amplitude of vibration is to be determined. The upper leg of the frame is slightly inclined, and has attached to it by a thin, flexible spring hinge a heavy, flat-plate pendulum supporting a micrometer microscope as its outer end. This pendulum plate has a very slow period and becomes the "steady point" of the combination. Directly beneath the microscope at the end of the horizontal part of the frame is a narrow slit illuminated by an electric light. By looking through the microscope with the instrument at rest, the width of the slot is adjusted to, say, five divisions on the illuminated scale; then with the machine running, any apparent increase in the width of the light slot is due to vibration. The amplitude of the vibration of the machine under test can be directly determined by proper calibration of this amplitude with relation to the fundamental amplitude of vibration of the vibroscope.

In connection with vibration and the fatigue of metals the following statement has been obtained from Prof. C. A. Adams, Chairman of the Engineering Division, National Research Council:

> A very comprehensive research into the fatigue of metals is being conducted at the University of Illinois under the auspices of the Engineering Division, National Research Council, and under the direct supervision of Prof. H. F. Moore, with the assistance of an advisory committee of the Engineering Division.
>
> The amount appropriated by the Engineering Foundation Board for this research is $15,000 per year for two years. In addition to this, the University of Illinois contributes, in the services of Professor Moore and other overhead expenses, the equivalent of at least $6,000 per year.
>
> The chief object of the research is to establish as far as possible such fundamental laws of the fatigue of metals as will make possible the intelligent design of apparatus and structures which are likely to be subjected to alternating stresses.
>
> The investigation will determine whether the stressing of the metal during vibration is above or below the elastic limit, and if below, how much time may be expected to elapse before rupture occurs.

It is expected that this experimental work by the National Research Council will furnish a great deal of valuable data in connection with the design of turbine blading and disks.

Gear-Driven Turbine Units—Erosion of Gears

The record of performances of small gear-driven units as experienced by operating companies has, in a number of instances, been far from satisfactory, the troubles being due in many cases to the abnormally excessive wear on the reduction gears.

An analysis of other gear troubles experienced indicates a number of reasons for their occurrence which summarize as follows: In some cases the oiling systems are incorrectly designed, or an improper grade of lubricating oil is used. Other cases of gear troubles are traceable to excessive or uneven tooth pressure, end play and poor meshing. The remedy for this class of trouble is purely of a mechanical character and readily corrected if detected in time. Mention has also been made of cases where the wear and tear on the gears has been aggravated by unbalanced rotating parts, or by foundations which have not been sufficiently rigid to maintain properly the correct alignment of the gear-teeth faces.

The manner and point of application of the oil to the gear are of prime importance. It is evident, therefore, that the oil must be applied at a point on the gear where it will most effectively reduce the friction to a minimum. The oil should be of a viscosity best adapted for the class of work intended, used in sufficient quantity, and applied to the entering side of the gear in a continuous film. Excessive oil does not improve gear lubrication and is likely in some cases to reduce the efficiency of certain types and design of gears, with a consequent increase of temperature. Sufficient space, however, should be provided in the gear casing so that when the oil has reached the maximum safe operating temperature it may be allowed to cool, rest and settle, to permit liberating as much as possible of the air or water globules it has collected during the period of work under actual churning conditions. Maximum oil temperatures allowable in best operating practice vary from 110 to 160 deg., according to the grade of oil and class of gear.

Examination of a number of gears from units which have been in operation over various periods of time, which were operated under proper conditions of lubrication, and where the alignment was satisfactorily maintained, shows a decided pitting below the pitch line in the gear and slightly above in the pinion, this line being the point at which the maximum tooth pressure occurs. A number of interesting experiments have been made during the last year, which seem to indicate that a considerable amount of gear erosion is due to causes other than those directly resulting from mechanical action.

Through the courtesy of Mr. S. K. French, of the American International Shipbuilding Corporation, a considerable amount of interesting information has been secured, based on the results which he has obtained in the investigation of gear operation in connection with gear drive for ship propulsion. It would appear that the pitting is due to the action of the oxygen content of the air in the oil film, which is entrapped under high pressure between the gear-teeth faces.

When the gear teeth come in contact with each other, the oil film on the gear is submitted to an action similar to that of a hammer stroke, more sliding than direct. The globules of air, which have been churned with the oil, are entrapped in this oil film, and are likewise submitted to a pressure sufficient to generate enough heat to cause an oxidization or burning of the metal in the tooth face. A number of experiments have already been carried out following this assumption. These experiments consisted in, first, adding a large quantity of oxygen to the gear casing; second, in supplying the gear casing with a mixture of nitrogen and CO_2. In the first series of tests, excessive pitting was noticed within a few hours' running, while in the operation of the gears in a mixture of nitrogen and CO_2, or where only a small amount of oxygen—approximately six per cent or less—was left, continuous operation over a long period of time indicated absolutely no pitting. Although the results cannot be regarded as conclusive, there is reason to believe that valuable information will soon be forthcoming, aiding in the solution of the problem of the more successful operation of gears. It is well known that certain classes of oils have a greater affinity for air and water than others of a different base or grade. These oils, after being churned with air or water and then allowed to settle, free themselves very slowly. It is evident that if this is true, the settling action, the size of the gear casings, the capacity of the oiling system, and the grade of lubricating oil must be given most careful consideration.

Higher Steam Pressures

Boiler manufacturers seem to feel certain that steam generators can be produced which will work satisfactorily at pressures as high as 1000 lb., but they all recognize the fact that such steam generators must be designed along lines different from those now in use. Present designs of water-tube boilers are variously estimated as adaptable to pressures of from 300 to 450 or even 500 lb.

Turbine builders express themselves as capable of producing turbines for any pressures for which boilers can be developed, but they place an upper limit on temperature. This limit is variously set at from 650 to about 800 deg. fahr.

Manufacturers of valves and fittings believe that they can produce such materials for steam pressures up to 1000 lb., provided the maximum temperature is limited to between 700 and 800 deg. fahr.

The majority of the manufacturers of power-plant equipment and the better known power-plant designers all seem to feel the desirability of using higher pressures as a means of continuing the development toward higher thermal efficiency which has been so rapid during the past two decades.

Power-plant executives will welcome anything which will assist in counteracting the effect of the ever-rising prices of fuel and labor.

This may all be summarized by saying that such information as is available indicates the possibility of building plants to operate at pressures not in excess of 400 to 450 lb. at temperatures not in excess of 700 to 800 deg. fahr, if it can be shown that the thermal gain actually realizable is sufficient to more than offset the increased first cost and probably increased maintenance. The boilers used would probably be heavy versions of present-day designs and not necessarily the most economical for such pressures.

However, it is not to be assumed from this summary that such an advance can be made in any easy fashion. Almost every piece of apparatus will require redesign and the highest type of engineering skill will be required to prevent costly failures.

In this connection attention is called to the fact that the A.S.M.E. standardization of flanges extends to a maximum of 250 lb. only.

At the present time 300 lb. with a total temperature of from 650 to 700 deg. fahr. may probably be taken as a conservative limit, and even under such conditions a high degree of operating skill is required even when the best obtainable apparatus is installed. Smaller plants which cannot ordinarily afford the most skilful operators will probably find the economic balance at a pressure in the neighborhood of 200 to 250 lb. and a total temperature not in excess of 600 deg. fahr. for some time to come.

As a result of these visits it can be stated that real operating difficulties have been experienced with valves and fittings operating at pressures in the neighborhood of 300 lb.

Welded joints in the steam line, such as were described in a previous report, are satisfactory so long as the line remains in continuous service. If cut out of service frequently, leaks develop at a rapid rate.

On large valve bodies by-pass valves and bonnet joints have given more trouble than usual.

Leaks developing under this pressure must be repaired at once because cutting of the metal occurs very rapidly. Attention is called to the fact that this corresponds to the experience of the builders of high-pressure steam automobiles, who found it extremely difficult to construct a tight throttle valve because of the rapidity with which the metal was cut away by the steam.

Blow-off valves have given more than the usual amount of trouble because of leakage, and similar statements can be made with respect to water column blow-off valves, valves on drips, and other small valves.

Influence of Microstructure of Metal on the Resistance of Condenser Tubes to Corrosion

The experience of the Southern California Edison Company with condenser tubes lasting over a period of eight and a half years at the Long Beach steam plant, has indicated that the microstructure of the metal has a great influence upon the resistance of the tube to corrosion.

As an illustration of the difference in tubes operating under similar conditions, there are three condenser units at Long Beach: No. 1 on a 12,000-kw., No. 2 on a 15,000-kw., and No. 3 on a 20,000-kw. turbine; all vertical machines, all taking water from the same tunnel and operating under practically the same temperatures.

In No. 1 condenser 21 tubes failed during 725 hours of operation; in No. 2 condenser 13 tubes during 2156 hours; and in No. 3 condenser 1892 tubes during 6232 hours. Thus there failed respectively 29, 6, and 336 tubes for 1000 hours of operation. The No. 3 tubes were found to be very coarsely crystalline, whereas both No. 1 and No. 2 tubes were of fine grain. Replacing the coarse-grained tubes with others of a fine structure cured the trouble.

Such microphotographic study as it was possible to make indicated that dezincification occurred round the crystal boundaries or possibly in the matrix surrounding the crystals. When the crystalline structure is coarse there is more tendency to local pitting; with fine-grained tubes the dezincification proceeds uniformly until the tube finally breaks from brittleness.

As a precaution against electrolysis the tube sheet was bonded to the condenser head and shell.

At times there was experienced trouble with erosion of the ends of the tubes which the water enters, this erosion extending in about three inches, probably until a steady condition of flow takes place. It has always been associated with dredging operations near the water intake and is attributable to fine sand in suspension. All the tubes are of Admiralty mixture, not tinned.

It would be of great advantage to condenser-tube users if some simple physical test could be applied to all tubes to indicate their fitness as regards microstructure, as actual microscopic study takes too long and is too expensive.

PULVERIZED FUEL

The past year has witnessed an increased number of powdered-coal-burning plants installed and a quite rapidly growing interest on the part of engineers in this development. The handling of powdered coal in large quantities has been successfully carried on in steel plants and cement mills, the coal being transmitted for a distance as great as 2000 ft. from the powdering plant. On the other hand, several companies are now placing on the market unit pulverizing equipments, one or two units being installed for each boiler. So far as the mechanical details are concerned, either the centralized powdering plant or the unit system seems to be highly satisfactory.

One of the earliest and largest plants with pulverized-coal equipment, both in combined capacity and capacity of individual boilers, is that built by Stone & Webster for the Western Avenue steam-heating station of the Puget Sound Traction, Light & Power Company at Seattle, Washington.

The Seattle installation was the outcome of extensive experiments, and the equipment is especially adapted for handling lignite washery sludge from a dump of about 200,000 tons at the Renton Mine, just outside of that city.

The boiler plant comprises ten boilers of an aggregate rated capacity of 4100 hp. The preparation plant includes: Raw-coal bunkers, roll-type crusher, crushed-coal bunker, rotary driers, drier-coal bunker, pulverizing mills and pulverized-coal bunkers, with the necessary conveying and transferring equipment. From the pulverized-coal bunkers the fuel is delivered by screw feeders to the burners. As the driers are fired with pulverized coal, and the entire preparation equipment is operated under a slight vacuum, the installation is practically dustless throughout.

The sludge burned reaches the plant carrying about 25 per cent moisture, with a heating value of 7500 B.t.u.; ash on the dry basis, 20 to 25 per cent. With this fuel boilers are operated on a steam-heating load at 150 per cent to 175 per cent rated capacity.

There are other installations in various parts of the country operating on somewhat less severe fuel conditions serving boiler plants of capacities around 2500 hp. which are also showing very satisfactory performance. Among these may be mentioned the 2340-hp. installation of The Milwaukee Electric Railway & Light Company at Milwaukee, Wisconsin, burning a mixture of Eastern Kentucky and Youghiogheny slack; the 1875 hp. of the British Columbia Sugar Refinery Company at Vancouver, B. C., burning the Nanaimo slack from Vancouver Island; the 2840 hp. of Morris & Company at Oklahoma City, Oklahoma, burning bituminous slack from the Arkansas-Oklahoma fields; and the 1800 hp. of the M. A. Hanna Coal Company at Lytle, Pa., burning anthracite slack.

Speaking broadly, however, the boiler installations, as now in operation, were not designed primarily for pulverized coal, but are adaptations of settings originally constructed for use with some other form of fuel and, on that account, are necessarily subject to many limitations inherent in previously existing local conditions. In spite of this handicap, the commercial practicability of pulverized coal as a boiler fuel has been thoroughly demonstrated. A number of installations are now under construction, designed throughout for the use of pulverized coal and thus freed from the limitations referred to, on which superior results may be anticipated. Proper volume and arrangement of furnace and simplicity in preparation and conveying equipment are the most important requisites of the successful installation.

Weighing the results so far obtained, we believe that the scope of application of pulverization to the steam power plant may be defined about as follows:

1 For a wide range of low-grade coals which only with great difficulty, if at all, can be handled on existing forms of mechanical stoker, pulverization offers a satisfactory means of efficient combustion.
2 For relatively higher-grade coals and very high in price, the slightly improved efficiency obtainable by combustion in pulverized form may frequently be sufficient to warrant adoption where size of the installation and annual load factor are such as to make small percentages in combustion efficiency of large moment in operating cost.
3 For reasonably good grades of coal available at moderate price, it is doubtful if the expense and complications of the pulverizing equipment can be justified—except in very large installations or in case of a very high annual load factor.

With regard to the comparatively recent development of unit pulverizing equipments, one or more for each boiler, the following report from the Erie City Iron Works is quoted:

> We have been conducting experiments in the burning of powdered coal under a power boiler. The pulverizing equipment is that manufactured by the Aero Pulverizing Company. The pulverizer is direct-connected to a variable speed motor. The coal is fed directly from our coal bunkers into a funnel-shaped hopper at the feed end of the pulverizer. The fuel is burned in a water-jacketed furnace applied to one of our old-style horizontal water-tube boilers. In connection with the test data which we give we wish to call attention to the fact that the boiler has been in service a great many years and the setting is far from being air-tight, thereby reducing the overall efficiency, which would otherwise be greater.
>
> We are at present experimenting with the pulverizer itself and expect in the near future to make improvments therein which will result in a considerably higher degree of fineness, which in turn should result in a higher overall efficiency being obtained. We also expect to produce this greater degree of fineness of the pulverization at a lower power consumption.
>
> A synopsis of the test referred to which was made in accordance with the Short Form Boiler Test advised by the Boiler Test Committee of the A.S.M.E. is as follows:

Percentage of ash in dry coal	11.47	
Calorific value of 1 lb. of dry coal	13,136	B.t.u.
Equivalent average per hr. from and at 212 deg. per sq. ft. of water heating surface	5.6	lb.
Percentage of rated capacity developed	162.6	%
Equivalent evaporation from and at 212 deg. per lb. of dry coal	10.08	
Equivalent evaporation from and at 212 deg. per lb. of combustible	11.38	
Efficiency of boiler and furnace based on combustible	74.4	%
Furnace temperature just within furnace	2,487	deg.
Stack temperature	508	deg.
Speed of pulverizer	1,480	r.p.m.
Lb. of coal as fired per hr	2,391	
Kw-hr. per ton of wet coal pulverized	31.	
Per cent moisture in coal before pulverized	6.44	
Per cent moisture in coal after	1.78	
Per cent through 200 mesh screen	41.6	
Per cent through 100 mesh screen	66.1	
Per cent through 65 mesh screen	79.8	
Per cent on 65 mesh screen	20.3	
Volatile in coal	30.3	%
Fixed carbon in coal	52.52	%
Ash	10.73	%
Sulphur	2.45	%
Draft in furnace	0.03	in.
Draft in damper	0.44	in.
CO_2	16.41	%
O_2	2.10	%
CO	0.11	%
Excess air	10.14	%

> The coal was fed into the furnace at the front of the boiler through a Y connection, each branch of the Y being 12¼ in. in diameter, this Y being directly connected to the pulverizer. No trouble was experienced due to Y connection clogging up.

WATER PURIFICATION—THE USE OF EVAPORATORS

In marine service it has long been common practice to supply pure make-up water for the boilers and other purposes from sea water by means of evaporators. The use of evaporators for supplying make-up water for generating stations has come into use only during the past four or five years. One of the first widely discussed installations of evaporators was that of the Buffalo General Electric Company. The following is from a letter from H. M. Cushing, Mechanical Engineer, giving information upon the operation of the evaporators:

> We have installed two 30,000-lb.-per-hour, Griscom-Russell three-unit, double-effect evaporators, taking steam at 200 lb. saturated. This

is obtained from a 275-lb. 275-deg. high-pressure line, by means of a reducing valve and desuperheater. The first equipment was installed in November, 1916, and the second one in April, 1919.

Our make-up runs between 5 per cent and 7 per cent. We have some reserve capacity in the evaporator equipment. For the year 1919 we evaporated 14,000,000 gal. of water.

In regard to economy, when one considers the one factor of cost of treated water per 1000 gal. of water used, the evaporator system will figure most expensive, but, although we have operated our boilers continuously from eight to ten hours a day at 300 per cent of rating, often operating at 400 per cent of rating for an hour at a time, we have had practically no boiler trouble, and none whatever traceable to the heavy loads which the boilers have been called upon to carry. We attribute this to the use of the evaporator system for obtaining our boiler make-up. We have had no pitting in our boilers or elsewhere on the feedwater system, although both the manufacturers and ourselves have searched diligently for signs of it.

The advantages and disadvantages of evaporators are given by the Committee in their report and are here summarized in brief form:

Advantages:

1 Practical elimination of boiler blowdown, which ranges from one to three per cent of the total feedwater.

2 Improvement in heat transfer due to elimination of scale.

3 Operation of the boilers over longer periods of time without shutdown.

4 Low operating cost of evaporation, which is automatic.

5 Almost entirely and permanently eliminates bad feedwater troubles.

Disadvantages:

1 Distortion of plant heat balance unless the entire electrical and steam-driven auxiliary system is laid out for the use of evaporators. The low thermal loss of an evaporator system depends on the fact that the latent heat of the vapor from one "effect" is used either as live steam in the next or for heating the feedwater above 210 deg. in a closed feedwater heater, or to 210 deg. in an open feedwater heater. Each "effect" used reduces the amount of vapor to be disposed of and consequently the amount of heat-balance distortion, but increases proportionately the first cost of the equipment. The "two-effect" system with vapor from the second effect going to the feedwater heater seems to be the more common layout for generating stations.

2 High first cost. If the proportion of make-up to total feedwater runs much over 8 or 9 per cent, either the heat-balance distortion is very great or the installation cost due to additional effects and perhaps a closed heater makes the cost of installation correspondingly high. Consequently there is an economic point somewhere around 10 per cent of make-up beyond which it does not pay to put in evaporators except in very special cases.

3 Leakage in condensers, sealing glands, etc., reduce the advantages of an evaporator system.

Short Abstracts of the Month

AERONAUTICS

Results of Tests on Radiators for Aircraft Engines, H. C. Dickinson, Mem. Am. Soc. M. E., W. S. James and R. V. Kleinschmidt. The present report is the fourth of a series of reports on airplane radiators, incorporating the results of experimental work at the Bureau of Standards under the joint auspices of that Bureau, the Aviation Departments of the Army, and the National Advisory Committee for Aeronautics.

Part I shows in tables and curves the results of measurements of geometrical characteristics of 59 types of radiators, together with such physical properties as heat transfer, head resistance, air flow through the core, power absorbed, and figure of merit. In most cases the properties are shown for speeds running up to 120 miles per hour.

The terms used in describing the radiators and their performance are defined, the more evident relations between the properties and characteristics are stated, and applications of the results to the design of a radiator are pointed out.

It is shown that the most efficient type of radiator tested, for use at high speeds and mounted in "unobstructed" positions on the aircraft, is one whose water tubes are flat hollow plates, placed edgewise to the air stream, and continuous from front to rear of the radiator.

Part II shows in curves the pressure heads required to produce given rates of flow of water in twelve sections of radiator, each of a different type, briefly described and shown in photographs, but each with a core 8 in. square. The methods used in the tests and in computation are stated in detail, and a method is developed for estimating, by the use of twelve sets of auxiliary curves, the pressure head required for a given rate of water flow in each type of radiator, when of any size, on the assumption that losses of head at inlet and outlet of the water tubes are negligible in comparison with the resistance in the tubes of the 8-in. sections. (Synopsis of Report No. 63, *National Advisory Committee for Aeronautics,* 1920, *e*).

AIR MACHINERY

Design of Air Ducts, J. C. Recommendations and chart for the determination of velocity in air ducts. The writer claims that in many cases the designer improperly figures the main duct as equal in area to the aggregate of the several branches, which gives to the main duct excessive proportions. Also an arbitrary velocity for the main duct is assumed which is considerably higher than that in the branches, with the result that the velocity for the main is excessive, the branches nearest the fan do all the work, and unnecessary use of metal is involved in making the duct larger than is really required.

In dust-extraction work it is important to maintain a velocity in the main duct equal to if not slightly greater than the velocity in the branches, so that no particle of dust is released from suspension until the dust separator is reached.

To solve this sort of problem the author plotted a chart (Fig. 1), the method of using it being as follows:

Suppose we require the size of main duct necessary to deal with fifty 5-in.-diameter branches. Let the eye follow up the line indicating 50 branches until the curve for 5-in. branches is encountered. If we now look along the horizontal line through the intersection of the said line and curve we obtain 24 in. diameter as the size required on the scale on the left-hand side of the chart. Now, fifty 5-in. branches total 981.75 sq. in., while the 24-in.-diameter main gives only 452.39 sq. in. This difference is brought about by the fact that there is a relatively greater frictional resistance offered by the smaller-diameter pipes owing to the factor (perimeter divided by sectional area) increasing as the diameter becomes less and less.

While the chart was prepared for 100 branches, the size of the main necessary to take the larger number of branches may be found (provided the main does not exceed 60 in. in diameter) by dividing the total number of branches into equal groups not exceeding 100 each, then finding the size of pipe required for each group, and finally looking up the size of main capable of dealing with these larger pipes. (*Mechanical World,* vol. 67, no. 1743, May 28, 1920, p. 346, 1 fig., *pA*).

BUREAU OF STANDARDS

The Saybolt Viscosity of Blends, Winslow H. Herschel. It has long been recognized that the viscosity of a mixture or blend of two oils is less than the arithmetical mean between the viscosities of the component oils. This is true whether viscosities are expressed in Saybolt seconds, poises or any other known unit of viscosity. For definite chemical compounds which are inert with respect to each other, a formula has been found which gives the viscosities of mixtures with great accuracy, but this formula cannot be used with oils whose molecular weights are not known.

For the purpose at hand, the best available formula was found to be

$$\log \mu = v_1 \log \mu_1 + v_2 \log \mu_2 \ldots\ldots\ldots\ldots\ldots [1]$$

where μ, μ_1 and μ_2 are the viscosities, in poises, of the blend and of the component oils, and v_1 and v_2 are the percentage volume concentrations. Expressed in words, Equation [1] shows that the viscosity of a blend is the weighted geometrical mean between the viscosities of the component oils, that is, the logarithms of the viscosities are additive.

If it is assumed that a Saybolt viscosimeter is used, the viscosity in poises may be obtained by the formula—

$$\mu = [0.00220\, t - (1.80/t)]\gamma \ldots\ldots\ldots\ldots [2]$$

where t is the time of flow, or Saybolt viscosity, in seconds, and γ the density of the oil at the temperature of test, in grams per cc.

It was found that the viscosities of blends, as determined by test, agreed in some cases fairly closely with the viscosities estimated from Equations [1] and [2], but the estimated value was always too low when there was a considerable difference between the viscosities of the component oils. For given component oils, the error increased as the amount of the lighter oil increased, reaching a maximum in a blend containing about 60 per cent of the lighter oil. It was also found that the percentage of error varied with the source of the crude oils, the maximum error being obtained if a heavy naphthene-base oil was blended with a light paraffin-base oil, and the minimum error being found with a blend of heavy paraffin and light naphthene oils.

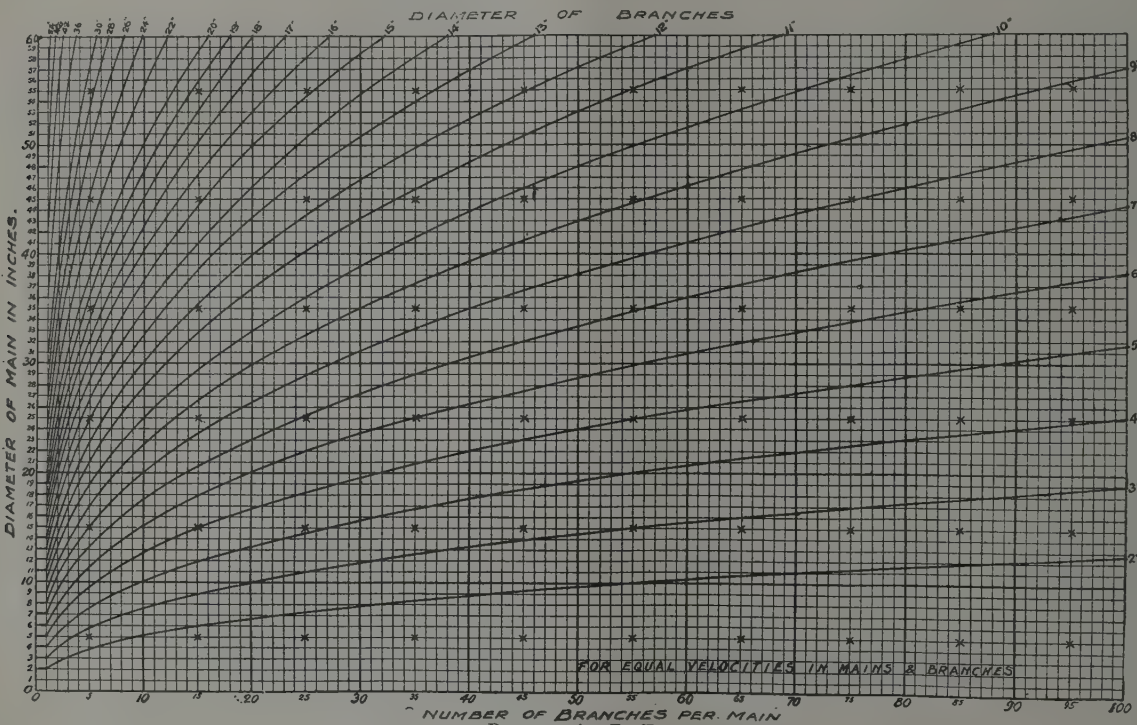


FIG. 1 CHART SHOWING SIZE OF MAINS FOR AIR DUCTS

In order to carry the difference in viscosity to an extreme, a heavy naphthene-base oil was mixed with aviation gasoline, and the error in estimating the viscosity of the blend was found to be 221 per cent. But even in this case the viscosity determined by experiment was not as low as would have been estimated on the assumption that the reciprocal of viscosities are additive, a rule sometimes advocated as the true law of mixtures. Within the range of viscosities actually employed in blending operations, it was found that the maximum error in the viscosity calculated from the logarithmic rule would be 33 per cent for naphthene-base oils or 25 per cent for paraffin oils. A diagram was obtained for estimating the correction factor to be applied to viscosities of blends as calculated from the logarithmic rule. It is believed that with the help of this diagram the viscosity of a blend may be estimated with an error not greatly in excess in determining the viscosity of the component oils. (Abstract of *Technologic Paper of the Bureau of Standards* No. 164, *ep*)

ENGINEERING MATERIALS

How Shortages of Metals Were Met During the War in Germany

WAR EXPEDIENTS IN THE FIELD OF METALS IN GERMANY, Albert Wuerth. The shortage of many metals in Germany during the period of the war forced manufacturers to resort to some interesting expedients which the present article describes. It further discusses the particularly important point as to the extent to which war practice in this field is likely to be maintained with the coming of peace conditions and restoration of the availability of the usual materials.

Engine and Pump Manufacture. Crankshaft housings for submarine engines have to be built of a special bronze having very high mechanical qualities, such as high tensile strength and high percentage of elongation. Since the beginning of 1915, due to the shortage of metals, these crankshaft housings were made of cast steel, which did not lead to any particular difficulties and, indeed, with the construction of larger sizes of submarine engines, proved to be an advantage, as it gave to the housing a greater rigidity. On the other hand, the machinability of the material proved to be poorer than that of bronze.

All the screws, bushings, etc., which before the war were made of bronze or copper castings, had to be of iron and sherardized in order to protect them against rust. (This was done by the Schoop process.) On the other hand, parts which used to be made of aluminum castings were during the war made of thin sheet iron and then galvanized.

Considerable trouble was experienced with piping. The former copper piping was replaced by steel piping galvanized inside and out. The zinc coating did not prove satisfactory, however, as it was rapidly eaten away by sea water and salty sea air. The pipes therefore had to be protected by lead, which, however, did not adhere well to the steel and chipped off easily under mechanical influences. It proved necessary to protect the piping by two coats of metal—zinc first and lead afterward. This required great skill in manufacture and a close control of the temperatures at which the metals were applied.

Vigorous efforts were made to conserve tin. Bronze bushings or parts under heavy stress (such as steering gears) used to be made of a bronze with a 15.5 per cent tin content. During the war these bronze bushings were made of an alloy containing about 30 per cent less tin and were not cast in sand, but in a metal mold so as to give them a greater hardness. This was based on investigations made in 1910 by Heyn and Bauer, which would indicate that the hardness of a copper-tin alloy is really a matter which may be controlled either by variation in tin content or by the proper control of temperature conditions during cooling, and, in particular, velocity of cooling. It should clearly be borne in mind that this hardening by rapid cooling is possible only with bronzes and not with brasses.

Bronze bushings with a tin content of 10 per cent were machined and after having been set in their seats were hardened on their surfaces by having a conical mandrel driven in under high hydraulic pressure.

Parts not subject to heavy stresses were made of zinc castings, and it appears that the strength of such parts was materially affected by the heat treatment which they used to undergo.

An effort was made to produce a bearing metal containing 52 per cent tin, 42 per cent lead, 2 per cent copper and 14 per cent antimony, but it has not as yet been carried to a successful conclusion.

Jet Apparatus. Considerable trouble was experienced in attempts to find substitute metals for use in jet apparatus, by which are meant nozzles and their equivalents through which water, steam, gases or acids are discharged under pressure. Here, in addition to other conditions, the tendency to corrosion and erosion had to be met. This latter particularly when the material discharged through the nozzle contained sand or suspended solids.

In particular, in injectors, attempts were made to substitute cast-iron nozzles for bronze, but it was found that the former did not stand up well when used either with steam or hot water. The inner wall of the nozzle was strongly corroded, which interfered with the efficiency of the apparatus. Tests were begun with various aluminum alloys for use in nozzles, but have not yet been concluded, and promising results were obtained with aluminum bronze containing 90 per cent copper and 10 per cent aluminum. This, however, would bring a saving only in tin and not in copper.

The water-atomizing nozzles in humidifying apparatus used to be made of bronze. During the war an attempt was made to make the housings out of so-called zinc bronze, leaving the general shape of the device the same as formerly and using bronze nozzles. It was found that housings so made would not stand up in service and broke easily and developed leaks. The shape was then altered and the main housing made of cast iron with screwed-in zinc bushings for water inlets.

In air nozzles made of zinc bronze unevenness of the surfaces rapidly developed, which made the atomizing incomplete and irregular. The reason for this was found to be the formation of zinc hydroxide, and the result of it was that much greater skill in attendance was necessary in order that good atomizing might be obtained.

Oil Preheaters. In Germany, during the war, the development of oil preheaters was of considerable interest. In ante-bellum days the jackets and covers of oil preheaters were made of bronze. Attempts were made to use steel castings as substitutes for bronze in covers, which led to certain mechanical troubles. The covers were then made with heavier walls and out of cast iron, but broke easily.

The design was then entirely changed, the brass tubes replaced by steel tubes and the cover made of thick wrought-iron disks, while the jackets were made of steel blocks. This latter did not prove satisfactory because in the machining of the blocks close to 90 per cent of the material was wasted which made the process expensive and not economical, in addition to which the riveting of the parts proved to be difficult. The jackets were made out of sheets and held in place by a combination of riveting and welding. (*Stahl und Eisen*, no. 13, April 1, 1920, pp. 421-426, 14 figs., serial article, not concluded, *d*)

FUELS AND FIRING

Burning Coke Breeze on Underfeed Stokers, F. A. DeBoos. Coke breeze, by which name the fine abrasions which are a by-product of coke manufacture are known, amounts to approximately 6 per cent of the total coke produced. In general, 40 per cent will pass through ½-in. mesh screen and 60 per cent through a 1⅛-in. mesh. These sizes, however, are too small for blast-furnace work, and, in particular, for the finer particles ranging from dust to sizes around ⅜ in., the demand is very slight.

The material has a good heating value, averaging on a dry basis 10,000 to 11,000 B. t. u., but is difficult to burn efficiently. Various attempts have been made to burn it either mixed with coal or on specially designed stokers of the chain-grate type, but there are objections to either of these methods. Furthermore, in many plants the amounts of coke breeze available are not sufficient to give the full power demanded, and coal-fired boilers must be used. In such installations there is a demand for a stoker which will burn varying mixtures of coke breeze and coal and which will have the ability not only to give good ratings and good efficiencies with such mixtures but will also be capable of securing extremely high ratings with proper efficiencies when burning all coal.

The author calls attention to the requirements for burning coke breeze and coal mixtures and also results of tests made at the Michigan Limestone and Chemical Co., Rogers City, Mich., with Jones A-C multiple-retort-type stokers.

In these tests a mixture of 225 lb. of coke breeze to 100 lb. of coal was burned with an efficiency of 65.6 per cent at 155.5 per cent rating; also with a mixture of 325 lb. coke breeze to 100 lb. coal, 141.1 per cent rating was developed with 59.1 per cent efficiency.

During the summer of 1919 tests were also made by the Ford Motor Co., in the course of which a mixture of two parts coke breeze to one part coal was first used, and then changed to three parts coke breeze to one part coal. As a result of these tests they are now burning at the Ford Hospital, Detroit, Mich., a mixture of two parts coke breeze and one part coal quite successfully and at a considerable saving in cost. The coke breeze is stored in a bin separate from the coal and the charge is mixed by dropping alternate charges of coke breeze and coal into the traveling bin. The mixture then descends through a short chute into the hopper of the stoker.

When coke breeze and coal mixtures are burned light air pressure is necessary, as otherwise the fine particles of breeze are blown up into the baffling of the boiler or down on to the dump plate with the objectionable result that holes will develop in the fire.

This makes it necessary to keep the fuel bed fairly thin, as otherwise heavy clinkers will develop and make it impossible to use the light air pressure. Also coke breeze-coal mixtures must be held together so that the particles of coke may "freeze", thus permitting the air pressure to facilitate combustion. (*The Blast Furnace and Steel Plant*, vol. 8, no. 6, June, 1920, pp. 362-364, 2 figs., *pe.*)

INTERNAL-COMBUSTION ENGINES

Fuel-Injection and Regulation Methods in Heavy-Oil Engines

The Application of Liquid Fuel to Oil Engines, A. J. Nilson. The author discusses the subject of injection and devotes considerable space to the description of various systems for its regulation. Of interest is the Pasel design (Fig. 2) for cutting out three-quarters of the pulverizer rings and giving the fuel a less tortuous path.

A groove is cut in the valve spindle down to the level of the bottom pulverizer ring and the entry to this groove or channel at the upper end is blanked by a sleeve having two ports opposite one another and coinciding with the groove in the valve spindle. This sleeve is operated from the outside and can be turned so as to close the aperture as may be required.

Another method of controlling the injection shown operates electrically and was designed by Mirrless, Bickerton and Day.

Several solid-injection systems are also described. Of particular interest is the system used in the Blackstone engine, where duplex injection is employed, which is a compromise between the true Diesel air-injection engine and the solid-injection vaporizer type of the semi-Diesel. In this system (Fig. 3) blast air at a pressure of 350 lb. per sq. in. is taken to a pair of fuel inlet valves or atomizers, one of which opens with a slight lead on the other. The leading valve delivers a small charge of oil to a hot bulb and maintains this automatically and continuously at the required temperature for igniting the main charge at all conditions of load. The jet of flame from this hot bulb is arranged to escape into the main cylinder through an orifice which deflects the flame obliquely into the spray from the main fuel valve, causing the charge to burn rather than explode. The initial compression in the main cylinder is only 150 lb. per sq. in. and the engine might be described as a low-compression Diesel with pilot ignition were it not that the ignition originates from the heat of a hot bulb and not as a result of air compression.

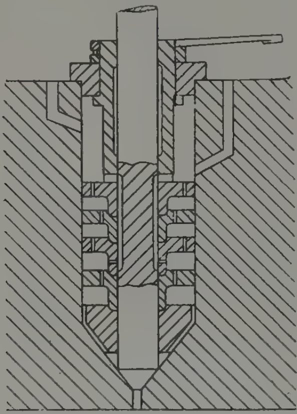


FIG. 2 PASEL BLAST-AIR INJECTION REGULATION VALVE (THE VARIABLE-RESISTANCE TYPE)

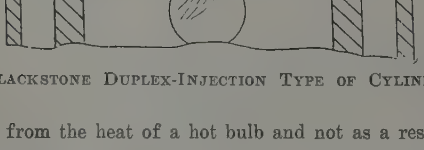


FIG. 3 BLACKSTONE DUPLEX-INJECTION TYPE OF CYLINDER HEAD

The Crossley oil engine is also described in considerable detail (compare MECHANICAL ENGINEERING, December, 1919, p. 896).

The subject of fuel ignition is discussed at some length and a good deal of attention is paid to the employment of tar oils as fuel for Diesel engines.

In this connection the choking of the pulverizer with black deposit is considered and the sleeve pulverizer introduced by P. H. Smith is described. It is stated that with this type of fuel valve the accumulation of black deposit is not as objectionable as in the standard type. The same trouble may be dealt with by running the engine for about fifteen minutes on gasoline every five or six hours, which clears out most of the deposit and renders it possible to run for long periods on tar oil without dismantling the fuel valve.

It is also stated that lignite oils are perfectly satisfactory in any Diesel engine which will run on a petroleum gas oil and no special apparatus is required as in the case of coal-tar oils. (*Journal of The Institution of Petroleum Technologists*, vol. 6, no. 22, April, 1920, pp. 141-165, 16 figs., and discussion pp. 165-185, 3 figs., *dg*).

Analysis of Conditions Affecting Slow Running of Automobile-Type Engines

THE LIMITS OF SLOW RUNNING, A. Johnson. It is well-known that as regards the ability to work efficiently at a low rate of revolution, the ordinary gasoline engine compares unfavorably with the steam engine. This is the reason for the use of change-speed gear drives in automobiles and numerous attempts to produce a slipping clutch (electric transmission).

As regards the mechanics of slow running, it may be noted that the low rate of speed is favorable to the induction of a large quantity of explosive mixture and thus to the attainment of a high pressure at the beginning of the compression stroke. On the other hand, the compression stroke itself is performed slowly and therefore the mean effective pressure is comparatively low. The balance of these two opposing causes, other things being equal, determines the speed at which the mean effective pressure is a maximum.

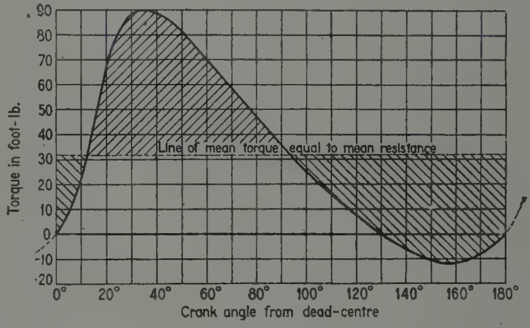


FIG. 4 TORQUE CURVE FOR A 4-CYLINDER ENGINE RUNNING LIGHT

Fig. 4 shows an approximate torque curve for a 4-cylinder engine, 4-in. bore by 5-in. stroke, running light. The internal friction in this engine is estimated to be equal to a constant torque of 32 ft-lb. When the crank is at either dead center the torque is zero and does not become equal to the frictional load until the crank has turned through 12 deg. From 12 deg. to 93 deg. past the dead center the engine torque is in excess of the load, and from 93 deg. to 192 deg. it is again insufficient to overcome the resistance.

Because of this the revolving mass of the engine is accelerated between 12 deg. and 93 deg. and decelerated between 93 deg. and 192 deg.

The shaded area above the line of mean torque in the diagram represents work done by the engine in accelerating the flywheel or equivalent revolving mass, and the shaded area below that line represents work given up by the flywheel to compensate for the defect of engine torque. These two areas must be equal if the rate of revolution is to return to the same value at each 12 deg. of crank advance from either dead center, and considering the total lower area, it will be found by measuring the diagram that the mean height represents a torque of 28 ft-lb. exerted during the crank's passage through 99 deg.

The work done or given up by the flywheel is therefore $28 \times (99/360) \times 2\pi = 48.38$ ft-lb., which is also the amount of work previously done by the engine in accelerating the flywheel under the assumption made above.

Assigning certain arbitrary values to the dimensions and weight of the flywheel or its equivalents, the writer obtains a mean rate of revolution for a given engine of 33 r.p.m., which is the absolute minimum rate of revolution for the engine and flywheel, assuming, however, that at such a slow speed the pressure in the cylinder would not vanish by cooling.

This rate of revolution is, however, the mean of zero and 66.43 r.p.m., which is the rate of revolution attained by the crank at 93 deg. past the dead center, and it is obvious that such extreme variations of rate within half a revolution cannot be permitted. If an arbitrary limit be set to the effect that the variation of speed shall not exceed 10 per cent of the maximum, it will be found that the mean rate of revolution is roughly 145 r.p.m., which is the lowest rate at which the engine will run light with a specified degree of regularity.

To determine whether the same flywheel running on the same limit of regularity will permit the engine under full load to run at a reasonably slow speed, it is assumed that in the full-load torque all the ordinates of the light-load diagram are multiplied by five. This, according to the author's calculation, brings the mean r.p.m. at slow speed under full load to about 324 r.p.m. This is probably slower than the engine will ever be required to run and will, in many cases, be lower than the speed of maximum mean effective pressure and therefore lower than the lowest speed at which the engine can run at full load. (*The Automobile Engineer,* vol. 10, no. 139, June 1920, pp. 231-232, 1 fig., *t*)

LUBRICATION (See also Bureau of Standards)

GRAPHITE LUBRICANTS, W. R. G. Atkins. In a brief paper the author describes the various forms of graphite lubricants and comes to the following conclusion:

It is obvious that to try to use graphite as a lubricant instead of oil would be useless, as solid friction is always greater than liquid friction. The oil used must be able to keep the metallic surfaces apart, either by its oiliness, its power of creeping with unbroken film over the metal, which necessitates a low surface tension, or by its viscosity, whereby it is carried along by the rotating portions, and wedged in between them and the fixed portions. To use an oil of viscosity more than sufficient to do this is wasteful, as energy is lost in shearing oil. Liquid lubricants, however, are greatly influenced by rise of temperature, and a decrease in viscosity of about 3 per cent per degree centigrade is quite a usual value for thick oils between 60 and 90 deg. cent. At cylinder temperatures all oils have very much the same viscosity. Under such severe conditions liquid oil films are apt to break, so the presence of a solid lubricant like graphite, which is almost entirely unaffected by such temperatures, is highly desirable. Graphite, then, may be considered as a lubricant of special value for cylinders and valves of internal-combustion engines. It is also of value for use on bearings, especially when subjected to heavy pressure, in which case the oil film may fail. A graphite film in a bearing, besides reducing the solid friction of metal to metal, also provides a skin which is renewed from the oil, this skin being worn away instead of the metal. After graphite has been in use in an engine for some time the amount in the oil (always a very small quantity) may be further reduced, for once the graphite surface is formed a very small quantity suffices to maintain it. It is difficult to explain why the use of graphite reduces the consumption of lubricating oil, but it undoubtedly does so. The film deposited is too thin sensibly to alter the clearances. The explanation which appears the most probable is that by reducing the friction and the eddy currents in the oil due to surface irregularities, the temperature of the oil film is, on an average, reduced, and its viscosity being on that account greater, its rate of flow is diminished. It is also possible that, on the cylinder walls, where oil probably vaporizes with the fuel, a certain residue of graphite remains, and in this case the clearances between piston rings and cylinder walls may be slightly reduced. Apart, however, from any explanation of its action, the saving is an established fact, and in certain cases it appears that power is also saved. (*The Automobile Engineer,* vol. 10, no. 139, June 1920, pp. 239-240, *g*)

MACHINE ELEMENTS AND DESIGN

Cam Design for Radial and Rotary Engines

CAMS FOR RADIAL AND ROTARY ENGINES, Wm. John Walker. The writer attempts to determine by a general method whether or not any multi-lobed cam will, by being geared to run at an appropriate speed, perform its functions correctly. The method given by the author is applicable to the problem of designing a cam disk geared to revolve in the same direction as the crankshaft.

In Fig. 5 is illustrated a tappet distribution for a 9-cylinder engine, but the tappets have been numbered to correspond to an engine having any number of cylinders, n. The cam is shown with only one lobe, so that the figure is equally applicable for a cam revolving in either the same or in the opposite direction to that of the crankshaft.

The author shows, among other things, that the correct angular distance between two consecutive lobes is $4\pi/(n-1)$ radians, and also that the total number of lobes of the cam disk must be $(n-1)/2$.

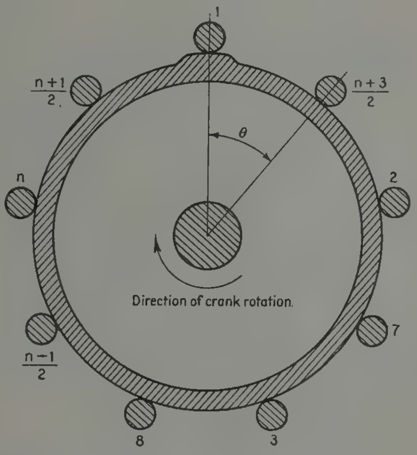


FIG. 5 TAPPET DISTRIBUTION FOR A 9-CYLINDER RADIAL AND ROTARY ENGINE

If the cam is geared to revolve in the same direction as the crankshaft, it must be geared to revolve at $1/(n+1) \times$ the speed of rotation of the crankshaft. Also the angular distance between two consecutive lobes must be $(n+1)/2$.

Thus, in the case of a 9-cylinder radial stationary engine, the two possible multi-lobed cams are either (1) the 4-lobed cam geared to run at ⅛ crankshaft speed in the direction opposite to that of the crankshaft, or (2) a 5-lobed cam geared to run at 1/10 the speed of, and in the same direction as, the crankshaft. The same applies to the case of the rotary engine, the cylinder speed being considered instead of the crankshaft speed. (*The Automobile Engineer,* vol. 10, no. 139, June 1920, p. 241, 1 fig., *t*)

Emergency Design of Bicycle Chain to Meet Present Shortage

NEW BICYCLE CHAIN. Last May a conference of jobbers in bicycle supplies was called together at the plant of the Diamond Chain Manufacturing Co., Indianapolis, to discuss the serious bicycle-chain shortage brought about by all the difficulties with which the majority of manufacturers have been confronted for the past several years. This shortage was the controlling factor in bringing about the situation where it is practically impossible to secure chains for replacements.

From reports made it would appear that the mills from which material for the rollers and bushings of the usual roller chains are obtained had been in constant labor trouble since July, 1919, and were closed completely from the end of September to December during the steel strike, while the production of some types of chains was not resumed until the middle of January. In addition, the working forces were seriously handicapped by the influenza epidemic during January and February, when for a period of about six weeks the absences among operators ranged from 25 to 45 per cent.

Under these conditions the Diamond Chain Manufacturing Co. recommended the employment of a new type of chain, or rather the revival of a type formerly used but produced by different methods.

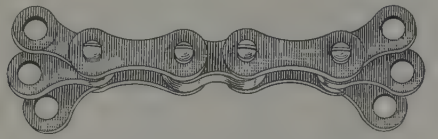


FIG. 6 THE ONE-INCH PITCH 3/16-INCH LEAF BLOCK CHAIN OF THE DIAMOND CHAIN MANUFACTURING CO.

With roller chains it is difficult to create increased production. The limiting factor is in the manufacture of bushings and rollers as the equipment for these parts is even now being driven to the limit. Material for these parts in increased quantity is not obtainable and the special machinery required for manufacture could not be produced under many months.

To meet this serious situation the leaf block chain (Fig. 6) has been designed. It is made up of a series of stampings and therefore does not require special machinery to produce it as is necessary in the production of roller and solid-block chains. It can also be assembled much quicker than either roller or solid-block chains. In general design it is similar to chains produced many years ago before the solid-block chain came on the market and is recommended especially for replacement business until the industry has picked up with the demand upon it. (*Motorcycle and Bicycle Illustrated,* May 13, 1920, pp. 37-39, 2 figs., *d*).

MECHANICAL PROCESSES

ROLLED PRODUCTS OF 99 PER CENT NICKEL, Edwin F. Cone. Ninety-nine per cent nickel can now be rolled into the various shapes into which mild steel is rolled; and not only that, but forgings have been attempted with success. It appears that nickel products can be fabricated with no more difficulty than those of mild steel, and as the same apparatus is used for working the nickel as is used for steel, it is possible to alternate the rolling of steel and nickel products without any changes or adjustments in the machinery. This is done at the plant of the Nickel Alloys Company at Hyde, Clearfield County, Pa.

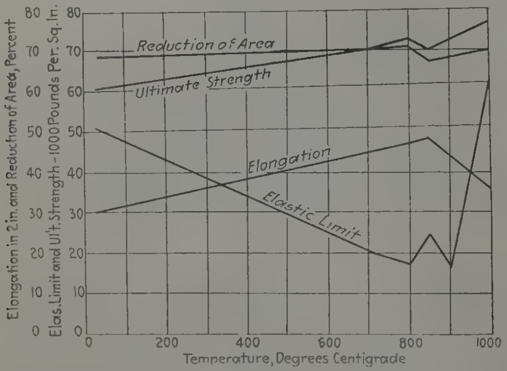


FIG. 7 THE PHYSICAL PROPERTIES OF 99 PER CENT ROLLED NICKEL

Pure nickel products are of value wherever non-corrodibility and ability to maintain an article in an antiseptic condition are of importance; for example, in dairy machinery, dyehouse equipment, etc. The new product is said to be malleable, can be welded to iron, steel or to itself, has a melting point of 1485 deg. cent. and the physical properties shown in Fig. 7.

The raw material is refined and specially treated in small 2- to 3-ton open-hearth furnaces. The hot metal is poured into ordinary ingot molds at a temperature of approximately 3200 deg. fahr. These ingots are later broken down under hammers or in rolls after the usual preheating. Sheets are rolled down in packs of 8 to 32 sheets to a thinness of 0.001 in.

The following data in addition to the curve are available as to the physical properties of the material:

Transverse test on a 1-in. diameter hot-rolled bar:	
Elastic limit	27,500 lb. fiber stress
Ultimate strength	84,300 lb. fiber stress
Modulus of elasticity	16,500,000 lb. fiber stress
Torsion test of a 1-in. rod, hot-rolled:	
Elastic limit	12,250 lb. fiber stress
Ultimate strength	80,800 lb. fiber stress
Degrees of twist per running inch	320 deg.
Complete twist in 24 in.	21 revolutions

The metal is of great flexibility and does not appear susceptible to the formation of scale, even under the most trying conditions. (*The Iron Age,* vol. 105, no. 25, June 17, 1920, pp. 1713-1716, 9 figs., *dA*)

MECHANICS

Load-Carrying Capacity of an Angular-Contact-Type Ball Bearing

LOAD CHARACTERISTICS OF RADIO-THRUST BEARINGS, F. C. Goldsmith. The article is a reply to one by F. W. Gurney which appeared in a previous issue of the *American Machinist.* The author is chief engineer of the New Departure Manufacturing Company.

The part which is of particular interest is that in which the author establishes an equation for the load-carrying possibility of an angular-contact type of ball bearing in terms of certain known quantities. The notation which the author uses is:

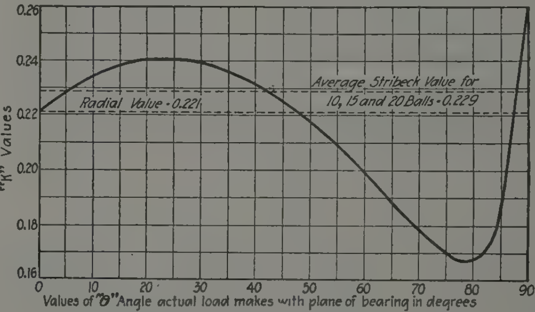


FIG. 8 CURVE SHOWING VARIABLE FACTOR AGAINST VALUES OF LOAD ANGLE IN A CERTAIN TYPE OF BALL BEARING

P = total resultant load on one ball row
P_0 = load on bottom ball in direction of contact
θ = angle between line of load application and plane of balls
α = angle between balls in vertical plane
β = angle of contact, and
$\eta = \omega_\eta = 0$

where ω is angle between line of load application and contact lines.

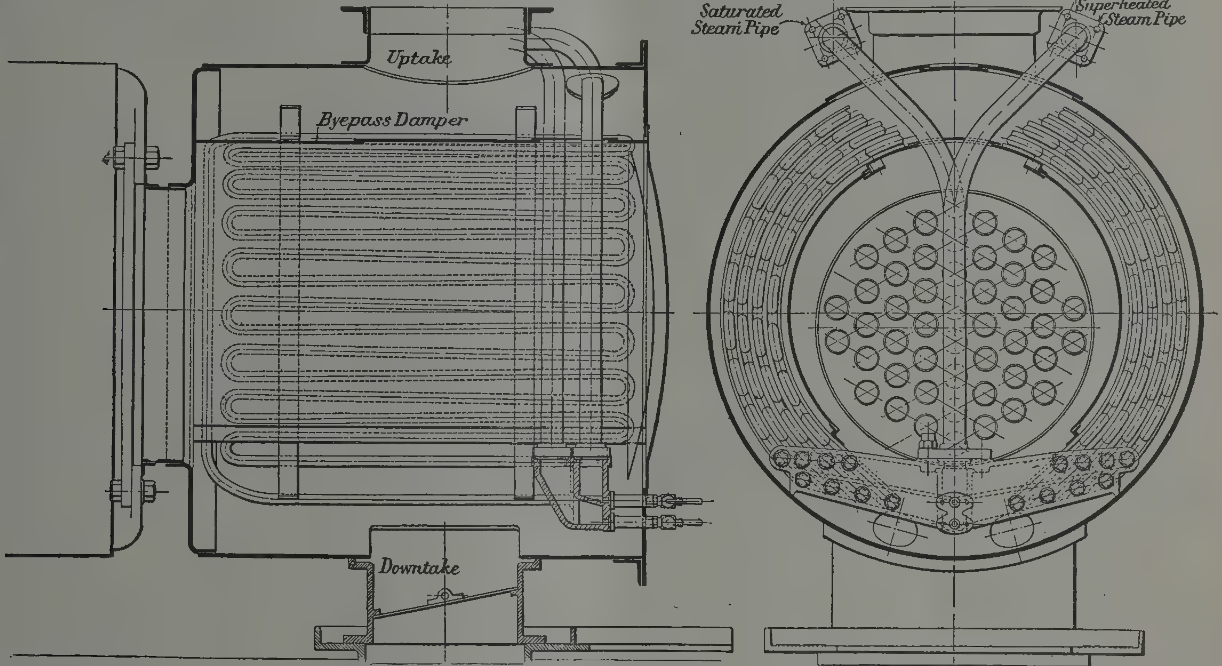
With this notation the author derives the formula—

$$P = P_0 \left\{ \cos(\theta - \beta) + \frac{2}{\cos^{1.5}(\theta - \beta)} \left[(\sin\theta \sin\beta + \cos\theta \cos\beta \cos\alpha)^{2.5} + (\sin\theta \sin\beta + \cos\theta \cos\beta \cos 2\alpha)^{2.5} + \ldots (\sin\theta \sin\beta + \cos\theta \cos\beta \cos\eta\alpha)^{2.5} \right] \right\}$$

from which one can see that for any one value of the load angle θ all other quantities are known. By solving this equation for bearings containing 10, 15 and 20 balls and letting θ vary through 90 deg. one can arrive at a variable factor which has a fixed value for each corresponding value of θ. Plotting these values of the variable factor against degrees of the angle of load application, the author obtains a curve from which, the angle of load application being given, one can pick the proper value of one of the principal bearing load factors.

In Fig. 8 is given such a curve showing the variable factor K in ordinates against values of the load factor θ as abscissæ for a popular line of thrust angular-contact type of ball bearings, the values of K being the average of bearings having 10, 15 and 20 balls.

In this figure, as a dotted line, is shown also the reciprocal of the number 0.229, which is the average value of the constant from the Stribeck equation for radial or annular ball bearings having 10, 15 and 20 balls. This is done to bring out the fact that for some load angles this bearing will carry a greater load than an annular bearing of the same size can carry, even as a pure radial load.



FIGS. 9 AND 10 SUPERHEATER OF MARSHALL, SONS & CO. COMBINED LOCOMOBILE

The following may be said as to the use of the curve in question: All speed-load catalog ratings are given as pure radial loads, and the corresponding value of K would be 0.221. Now, supposing the angle of load application happens to be 25 deg., the corresponding value of K would be 0.24, and in selecting the proper size of bearing from the catalog rating we would multiply the resultant load by 0.221 over 0.240 or

$$\text{Catalog load} = \frac{0.221}{0.240} \times \text{resultant load} = 0.92 \times \text{resultant load}$$

In case the load angle proved to be 85 deg.,

$$\text{Catalog load} = \frac{0.2210}{0.1675} \times \text{resultant load} = 1.32 \times \text{resultant load.}$$

After a careful study of this curve we can see that when the load angle is less than 48 deg. we really have in this angular-contact-type ball bearing a very excellent load-carrying device.

The author also gives an interesting curve sheet (Fig. 10 of the original article) such that after the radial and thrust loads have been determined one can readily arrive at the proper bearing size. (*American Machinist*, vol. 52, no. 23, June 3, 1920, pp. 1190-1196, 10 figs., *t*)

POWER PLANTS

COMPOUND LOCOMOBILE WITH SUPERHEATER. Description of the locomobile built by Marshall, Sons & Co., Ltd., Gainsborough, England.

The engine is a 2-cylinder compound mounted on a cylindrical tubular boiler. This latter is 6 ft. 1 in. in diameter and has a length of 16 ft. It is fitted with a single flue 4 ft. 3½ in. in external diameter and 7 ft. 7 in. long. The tubes are 129 in number and 2½ in. in external diameter, giving a total heating surface of 769 sq. ft., of which 79 sq. ft. represent the flue surface.

A smokebox superheater, Figs. 9 and 10, provides 600 sq. ft. while a horizontal feed heater through which the exhaust from the low-pressure cylinder passes on its way to the condenser furnishes 65 sq. ft. of heating surface. The boiler pressure is 180 lb. per sq. in. and in tests reported in the original article it was found that the coal consumption per brake horsepower per hour was 1.7 lb. running non-condensing and 1.39 lb. condensing with the heat value of coal of 11,500 B.t.u. The engine is furnished with a jet condenser, together with an Edwards-type vertical air pump. The feed pump is fixed to the air-pump casting and works off the same eccentric rod. The feed is passed through the tube at the feed heater. An injector is fitted to the boiler as a stand-by.

In connection with Figs. 9 and 10 it may be added that they represent the general arrangement of the superheater, but not the actual arrangement adopted for this size of engine. (*Engineering*, vol. 109, no. 2840, June 4, 1920, pp. 767-768, *d*)

STEAM ENGINEERING (See Power Plants)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Research Association in Great Britain

In addition to those listed in the March issue of MECHANICAL ENGINEERING (p. 181), the following Research Associations have received licenses from the Board of Trade under Section 20 of the Companies' Act of 1908:

The Glass Research Association, 50, Bedford Square, W. C. 2, Secretary, E. Quine, B. Sc.
The British Non-Ferrous Metals Research Association, 29, Paradise St., Birmingham, Secretary, E. A. Smith, A. R. S. M., M. Inst. M. M.

The following Rssociations have been approved, but not licensed:

British Music Industries Research Association
The British Refractory Materials Research Association
The Scottish Shale Oil Research Association
The British Leather Manufacturers' Research Association
The British Launderers' Research Association.

The following Associations are under consideration:

The British Electrical and Allied Industries Research Association
The British Aircraft Research Association.

The following Associations are preparing memorandum and Articles of Association:

Silk Manufacturers
Master Bakers and Confectioners
Cycle and Motor Cycle Manufacturers
Users of Liquid Fuels

Research Laboratories In and About Washington

The following list of laboratories has been prepared by Mr. C. A. Briggs, Associate Physicist of the Bureau of Standards:

Industrial Research Laboratories:
- Institute of Industrial Research, 19th & B Sts., N. W., Washington, D. C.
- National Canners' Association, 1739 H St., N. W., Washington, D. C.

Endowed Laboratories:
- Geophysical Laboratory of the Carnegie Institution
- Department of Terrestrial Magnetism of the Carnegie Institution.

Laboratories of Educational Institutions:
- American University
- Bliss Electrical School
- Catholic University
- Gallaudet College
- Georgetown University
- George Washington University
- St. John's College
- Trinity College
- Washington Missionary College.

Departmental Laboratories:
- Bureau of Chemistry—10 laboratories
- Other Bureaus of the Department of Agriculture—22 laboratories
- Coast and Geodetic Survey—3 laboratories
- Bureau of Standards
- Bureau of Mines—5 laboratories
- Navy Department—17 laboratories
- Smithsonian Institution—4 laboratories.

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A10-20 Thermal Expansion. A stretched-wire apparatus for measuring thermal expansion has been developed by Dr. Arthur W. Gray. This instrument is simpler in form than the one designed by him for the Bureau of Standards. The Report in *Chemical and Metallurgical Engineering* for Nov. 26, 1919, gives the form of apparatus together with results from its use. The instrument is simple and gives accurate readings. Address Dr. Arthur W. Gray, L. D. Caulk Company, Milford, Del.

Cellulose and Paper A1-20 Gas Masks in Pulp and Paper Mills. Gas masks of a nose-breathing type with canisters containing special chemicals are used in the digester house of the Forest Products Laboratory at Madison, Wis. This mask enables the operator to make ready repairs of SO_2 leaks under conditions otherwise unbearable. They are of great assistance in bleach rooms. Address Forest Products Laboratory, Madison, Wis.

Electric Power A3-20 Safe Use of Alternating Type of Coal-Cutting Equipment. L. C. Ilsley and E. J. Gleim have recently made a report to the Bureau of Mines on machines, circuits, protection and switches for alternating currents applied to coal-cutting equipment. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Fuels, Gas, Tar and Coke A6-20 Evaporation from Crude Oil. J. H. Wiggins, Assistant Petroleum Engineer of the Bureau of Mines, has recently made a report showing a yearly loss of nearly $27,000,000 from evaporation of crude oil in the Mid-Continent oil field. This amounts to 3 per cent of the total gasoline produced in the United States. The major portion of this evaporation occurs on the lease when the oil is still fresh. It is possible to eliminate two-thirds to four-fifths of this evaporation by protecting oil from free contact with air. Bureau of Mines, Washington, D. C. Address Director.

Fuels, Gas, Tar and Coke A7-20 The Peat Resources of Ireland. Special Report No. 2 of the Fuel Research Board of the Department of Scientific and Industrial Research of Great Britain by Professor Pierce F. Purcell is to be issued. The subjects treated are: Origin and formation of peat deposits, occurrence of trees in bogs, physical properties of peat, elimination of water, area and fuel content of Irish peat deposits, peat deposits of other countries, hand winning, mechanical winning, uses, utilization, allowable moisture for producer work, reclamation and cultivation of bogs. Price by post, 11d, obtained at Imperial House, Kingsway, London, W. C. 2.

Leather and Glue A2-20 Effect of Oils on Strength of Glues in Plywood. Plywood near machinery and tanks containing oils may be used with little danger of the joints becoming weak through the action of the oil or gasoline. Plywood panels glued with animal, vegetable, albumen and casein glues were immersed for nearly a year in engine oil and gasoline. All the glues weakened somewhat during the early part of the test, the animal and vegetable glues showing the greatest reduction in strength. The total loss was small, however. In only two or three instances did the strength of the casein or the blood albumen glues fall below 150 lb. per sq. in. The shear strength of the glue of 100 to 125 lb. per sq. in. was found in most cases. During 45 weeks the wood absorbed 60 per cent of its original weight of gasoline. Forest Products Laboratory, Madison, Wis. Address Director.

Machine Tools A1-20 Shearing Steel at High Temperature. Series No. 20 of the Engineering Experiment Station of the University of Missouri contains a paper by Guy D. Newton on Energy Necessary to Shear Steel at High Temperatures. Experiments were tried with a rotary shear and with a straight shear. The metal was heated in a gas furnace and temperatures were taken by a Hoskins thermoelectric pyrometer inserted in the specimen. The shearing energy was determined by the change in speed of the flywheel. The results are shown in Figs. 1 and 2.

Ventilation A1-20 Tests of Siphoning Ventilators. A series of comparative tests have been conducted by A. A. Potter, J. P. Calderwood and A. J. Mack, of the Engineering Experiment Station, Kansas State Agricultural College, to study the effectiveness of ventilators. The results of these tests are shown in Table 1.

All ventilators used in the tests were 10-in. Ventilators No. 1 and 2 were of the siphoning type (see Fig. 3), the wind velocity being utilized to create an additional current of air through the ejector tube. No. 3 ventilator was not intended to produce any siphoning effect.

A wind tunnel 26 in. square and 15 ft. long was utilized. A variable-speed fan was inserted in one end of the tunnel capable of reproducing wind velocities up to 15 miles per hour. The ventilator to be tested was placed in the other end of the tunnel. A 10-in. pipe extending through the bottom of the tunnel was inserted to receive the various ventilators.

In performing the test, a ventilator was inserted in the tunnel and the fan regulated to produce the proper conditions. The velocity of the air in the tunnel and that induced through the ventilator was measured by means of an anemometer.

During the test each ventilator was subjected to as nearly as possible the same condition. The speed of the fan being regulated to secure the desired result. The velocity of the air passing over the ventilator and that siphoned through the tunnel when no ventilator was inserted would induce a current of air through the uncovered pipe leading into the tunnel, this data was recorded and is referred to in Table 1 under the head "No Ventilator."

In deducing any conclusions from these results it should be remembered that under actual conditions the ventilator action would be more pronounced. The tests, however, are of value in that each ventilator was subjected to similar conditions and the results show their comparative value.

The increase in velocity of the air in the ventilator above that produced when no ventilator was used gives a direct measure of the siphoning action. No. 3 ventilator shows actually a retarding of the air in passing through the ventilator, while Nos. 1 and 2 ventilators show a decided siphon action.

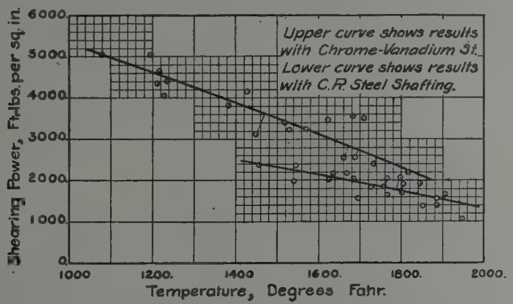


FIG. 1 ENERGY REQUIRED TO SHEAR STEEL AT HIGH TEMPERATURES WITH A ROTARY SHEAR

Ventilator No. 1 was at a slight disadvantage in these tests, as it was larger in size than the other ventilators tested, and consequently obstructed the tunnel to a greater extent. This created a larger air pressure near the ventilator, increasing the tendency for the air to pass downward reducing the siphoning effect.

Address Director, Engineering Experiment Station, Kansas State Agricultural College, Manhattan, Kan.

Water, Sewage and Sanitation A1-20 The Bureau of Mines has recently received a report on the Collection and Examination of Rock Dust in Mine Air. This method consists in drawing air through a glass tube containing a layer of sized granulated sugar which filters the dust particles, using a calibrated air pump to measure the air. The sugar is then dissolved in distilled water, leaving the undissolved matter for examination. The sugar is submitted to an examination for insoluble matter before using it in the sampling tubes.

After dissolving the sugar a dust count is made from 1 cc. of the solution which has been made up to about 500 cc. by distilled water. The work was done by W. A. Selvig, F. D. Osgood and A. C. Fieldner. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

TABLE 1 RESULTS OF TESTS ON VENTILATORS AT THE ENGINEERING EXPERIMENT STATION, KANSAS STATE AGRICULTURAL COLLEGE

Velocity of air, miles per hour.	Velocity of Air in Ventilators in Feet Per Minute			
	No ventilator.	Ventilator No. 1.	Ventilator No. 2.	Ventilator No. 3.
1	26	35	30	17
2	55	70	61	36
3	85	106	93	55
4	112	143	123	73
5	140	178	153	90
6	168	213	183	107
7	197	250	213	126
8	224	286	244	144
9	252	319	274	162
10	280	235	305	179

Water, Sewage and Sanitation A2-20 Sulphur Dioxide as a Factor in the Smoke Problem of Salt Lake City. G. St. John Perrott has recently made a report to the Bureau of Mines on the sulphur dioxide contained in the atmosphere at Salt Lake City. The results show that the concentration is at no time to be an important factor in polluting the atmosphere and that most of the sulphur dioxide comes from the combustion of fuel in the city. At 12 noon the concentration is 0.1 part per million, while the greatest concentration occurs before 10 a. m. The concentration is higher on smoky days than on clear days and it decreases with the wind. The average concentration in December and January was about 0.15 part per million, while in March it was 0.01 part per million. Six parts per million have been observed in London, 0.6 part in Berlin and 1.8 parts in San Francisco. Samples taken by an airplane at 3000 ft. elevation, 2000 ft. elevation and 1000 ft. elevation showed a trace of sulphur dioxide. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

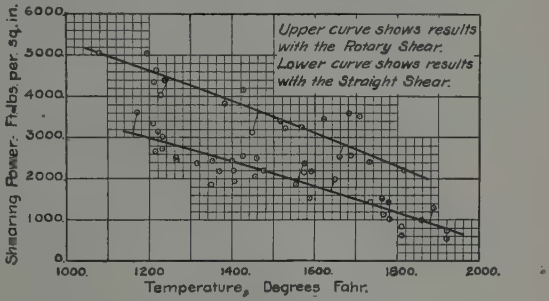


FIG. 2 ENERGY REQUIRED TO SHEAR CHROME-VANADIUM STEEL AT HIGH TEMPERATURE WITH ROTARY AND STRAIGHT SHEARS

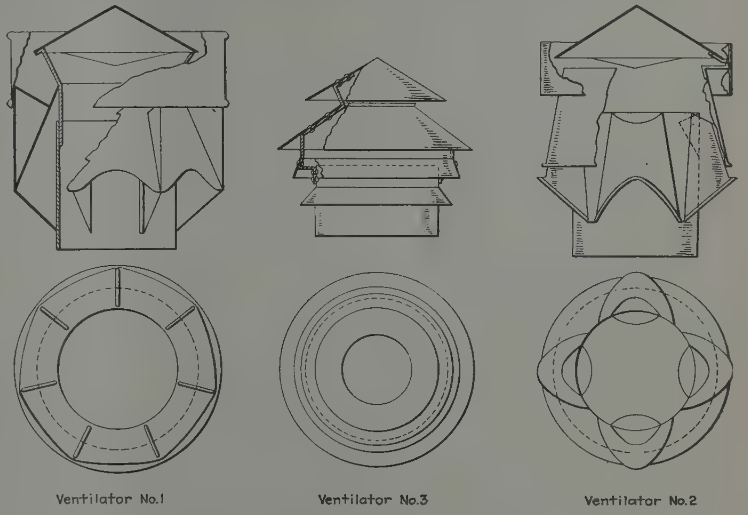

Ventilator No. 1 Ventilator No. 3 Ventilator No. 2

FIG. 3 TYPES OF VENTILATORS TESTED

Wood Products A7-20 Preservation. Light creosote oils properly injected into wood will prevent decay until the wood wears out or until it checks so badly that untreated portions are exposed. The heavier creosote oils used 25 or 50 years ago gave similar results. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A8-20 Drying Periods. Table 2 gives the approximate time for kiln drying under mild conditions of 1-in. boards in green condition and partially air-dried to reduce the moisture content to 6 per cent of the weight of the dry wood. For stock greater than 1 in. and not more than 3 in. in thickness the drying time is proportional to the thickness. Quarter-sawed stock requires from 25 to 35 per cent more time. If the drying is carried on to 10 or 14 per cent instead of 6 per cent, the time is reduced to 1-4 or 1-3 less than before.

Address Director, Forest Products Laboratory, Madison, Wis.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work

TABLE 2 APPROXIMATE TIME REQUIRED TO KILN-DRY, UNDER MILD CONDITIONS, 1-IN. PLAIN SAWED STOCK TO MOISTURE CONTENT OF 6 PER CENT, BASED ON WEIGHT OF DRY WOOD

Species	Days drying time	
	Green from the saw	Partially air-dry (25 per cent moisture content)
HARDWOODS:		
Swamp oak	45 to 50	20 to 25
Northern oak	30 to 40	17 to 20
Walnut, cherry	22 to 30	13 to 15
Mahogany, beech	16 to 22	9 to 12
Tupelo, gum	20 to 26	10 to 14
Birch, ash, sycamore	15 to 21	9 to 12
Poplar, basswood, chestnut, butternut, elm, cherry	8 to 10	4 to 6
Maple, hickory	17 to 23	9 to 13
CONIFERS:		
Western larch	9 to 12	4 to 6
Cypress, redwood	10 to 18	6 to 8
Douglas fir, yellow pine, incense cedar, spruce	4 to 6	3 to 4

and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Fuels, Gas, Tar and Coke B2-20 Volatility of Motor Fuels. An investigation to determine by vapor-tension apparatus the minimum temperature to establish a stable mixture of air and gasoline vapor in combining proportions. Address Frank A. Howard, Standard Oil Company, 26 Broadway, N. Y.

Fuels, Gas, Tar and Coke B3-20 Crushed Fuel. A new method of burning crushed fuel is being developed at Purdue University. Fuel is introduced after crushing to small-size grains through tuyeres at one side of a circular hearth. The coal is introduced by means of an air current through a fan blower, additional air for combustion being introduced by side openings. High capacity has been obtained with ease of control and regulation. The cost of operation is much less than that of the pulverized-coal methods. Address Professor G. A. Young, Purdue University, Lafayette, Ind.

Heat B5-20 The Heat Transmission of Cork and Lith Board. A series of experiments in preparation for the winter meeting of the Society. Address Prof. J. P. Calderwood, Kansas State Agricultural College, Manhattan, Kan.

Internal-Combustion Motors B6-20 Condition of Air Flow Through Radiators. Investigations on the condition of air flow through airplane cooling radiators. Twenty-four specimens have been tested so far. The problem of direct cooling of the engine is being studied and progress is also being made in determining the temperature distribution in the air cells of certain cooling radiators. A comprehensive technical paper is being prepared. Address Dr. S. W. Stratton, Bureau of Standards, Washington, D. C.

Internal-Combustion Motors B7-20 Carburetion of Fuels. Determination of the effect on the power and thermal efficiency of a tractor engine of varying the temperature of the fuel and air as it enters the carburetor. Quite elaborate apparatus is used to determine the temperature and pressure in the whole fuel intake system and to maintain exactly the conditions desired. Address C. W. Good, Department of Mechanical Engineering, University of Michigan, Ann Arbor, Mich., or Asst. Prof. W. E. Lay, Charge of Automobile Engineering, University of Michigan, Ann Arbor, Mich.

Steam Power B2-20 Corrosion of Steam Pipes. An investigation of the corrosion of steam pipes at Iowa State College. Results so far seem to indicate the presence of CO_2 as the cause of corrosion. Address Prof. M. P. Cleghorn, Iowa State College, Ames, Ia.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Pennsylvania College D1-20 The Department of Mechanical and Electrical Engineering of Pennsylvania College, Gettysburg, Pa., has the following equipment:

One Riehlé 100,000-lb. testing machine.
One Riehlé 1000-lb. cement-testing machine.
One gage tester
Miscellaneous electrical and mechanical equipment.

E—RESEARCH PERSONAL

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Fuels, Gas, Tar and Coke F5-20 Fuel Oil. A bibliography of one page. Address A.S.M.E., 29 West 39th St., New York.

Internal-Combustion Motors F1-20 Spark Plugs. A bibliography of one page. Address A.S.M.E., 29 West 39th St., New York.

Petroleum, Asphalt and Wood Products F3-20 Petroleum and Allied Substances. The Bureau of Mines has compiled by E. H. Burroughs a list of recent articles on petroleum and allied substances. This bibliography is prepared each month. Address Bureau of Mines, Washington, D. C., F. G. Cottrell, Director.

Petroleum, Asphalt and Wood Products F4-20 The Natural Hydrocarbons such as gilsonite, elaterite, wurtzilite, grahamite, ozokerite and others by Raymond B. Ladoo, Mineral Technologist, Bureau of Mines. One-page bibliography of 22 items. Address Bureau of Mines, Washington, D. C., or A.S.M.E., 29 West 39th St., N. Y.

Water, Sewage and Sanitation F3-20 Process used in U. S. for Treatment and Filtration of Sewage Waters. A bibliography of three pages. Search 2955. Address A.S.M.E., 29 West 39th St., New York.

WORK OF THE A. S. M. E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 299 to 306 inclusive, as formulated at the meeting of May 24, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 299

Inquiry: In using Par. 212 to determine the maximum allowable internal working pressure that may be allowed on a staybolted surface under the Code Rules, it is stated that the weakening effect produced by drilling the staybolt holes must be considered. Cylindrical surfaces of the character referred to in this paragraph usually contain a riveted joint that weakens the structure more than does the drilling of staybolt holes. Should not the weakening effect of such joints be considered in the applying Par. 212?

Reply: Where the curved staybolted surface referred to in Par. 212 contains a riveted longitudinal joint or other construction except hand-holes, and the strength of the surface through such joint or other construction is less than through any line of staybolt holes in the same direction, the weakening effect of the joint or other construction instead of that produced by the drilling of the staybolt holes, is to be considered in making the calculations for pressure by this paragraph.

Case No. 300 (Annulled)

Case No. 301

Inquiry: Is it the intent of the Boiler Code under Par. 182 that the back pitch of tubes and rivets on drums which have a relatively high ratio of shell thickness to diameter of drum, shall be measured on the inside surface, the outside surface, or the median line of the shell?

Reply: It is the opinion of the Committee that in measuring the back pitch of tube holes or rivets, the measurements should be made on the flat plate before rolling, so that in checking up these measurements after construction, the result would correspond to the dimensions on the median line, or the mean of the measurements on the outside and inside surfaces.

Case No. 302

Inquiry: Is it the intent of Par. 278 of the Boiler Code which requires a full-sized direct connection to the boiler for each safety valve, that the exact meaning of this term shall be applied to small brass pop safety valves with male inlet connections: It is impossible to maintain the nominal threads on the inlet of these valves if the inlet opening is maintained full-sized in a male connection.

Reply: It is the opinion of the Committee that the rule given in Par. 278 of the Code applies to the connection leading to the safety valve and not to the safety valve itself. There need not be a full-sized opening through the valve itself, as the stamping of the capacity thereon by the manufacturer indicates in any case what is actually guaranteed for the valve by the maker.

Case No. 303

Inquiry: Is it the intent of the Boiler Code Committee in its references to commercial lap-welded pipe in Case No. 218 that the weld therein may be considered as conforming to the requirements for welded joints in Par. 186 of the Boiler Code?

Reply: For calculations of the maximum allowable working pressures to be permitted in open-hearth lap-welded pipe used in connection with boilers, it is the opinion of the Committee that the weld may be assumed as meeting the requirements of Par. 186.

Case No. 304

Inquiry: What amount of cooling and shrinking under pressure is necessary in the driving of rivets under the requirements of Par. 256 of the Boiler Code? Is it consistent with the intent of this paragraph to release the pressure while the rivet shows any degree of heat redness in color?

Reply: It is the opinion of the Committee that the pressure should be maintained upon the rivet after it is driven until no part of the head shows red in daylight.

Case No. 305
(In the hands of the Committee)

Case No. 306

Inquiry: Is it the intent of Par. 20 that the minimum thicknesses of tube sheets there specified for h.r.t. boilers is applicable also to vertical fire tube boilers and to locomotive type boilers?

Reply: It is the opinion of the Committee that while this paragraph refers specifically to h.r.t. boilers, it is equally applicable to boilers of the vertical fire tube and of the locomotive types, and its application to these two latter types is recommended by the Committee.

Have Engineers the Right to Prepare Legal Papers?

The New York Court of Appeals recently handed down an opinion which seemed to restrict the drawing of legal documents to persons possessing the right to practice law. This raised question in the minds of some engineers as to whether engineers and architects could continue in New York State to prepare contracts and certain other legal or semi-legal documents as has hitherto been their practice. It is the opinion of one legal authority, however, that engineers having special knowledge of the engineering work required and the professional skill enabling them to express it are not precluded as an incident in the practice of their profession from preparing "contracts for engineering work as has been the common practice for years." By so doing they are not holding themselves out as practicing law and are not practicing law.

The decision rendered by the Court of Appeals, Judge Crane writing the opinion, is that of People vs. Alfani (227 N. Y., p. 334). In that case there was evidence, as the chief judge said, "consisting of defendant's sign and repeated acts which permitted the trial court to find that the defendant held himself out to the public as being entitled to and did practice law." Defendant had a sign up advertising himself as a notary public and as a person drawing "all legal papers." The evidence showed that he did draw a bill of sale and chattel mortgage and advised as to the necessity of filing the mortgage in the county clerk's office and that he charged and received $4 therefor. When the client was leaving he inquired of the defendant, "In case I have any trouble of any kind and I need any legal advice, can I come back to you?" to which the defendant replied, "Yes."

In People vs. Title Guarantee & Trust Co. (227 N. Y., p. 366) a similar question arose in the prosecution against the trust company for drawing deeds and similar instruments in connection with their business of insuring titles to real estate, and the court held that such action did not violate the statute. The court says:

> We know that in cities constantly men engaged in the real-estate business and banks have prepared for their customers such instruments without doubt or criticism.
>
> The legislature when it enacted not only Section 280 of the Penal Law, which we have been considering, but also Section 270 relating to the practice of law by an individual without being admitted and registered, was charged with the same knowledge of prevailing customs and practices with which we are chargeable. Its members knew, oftentimes doubtless by practical and personal observation and experience, that laymen throughout the state were rendering such services as are here involved. Not only by practice and custom, but by inherent privilege they had the right to do this unless forbidden by statute, and if the legislature intended to prohibit a widespread practice and establish a new rule, it was its duty to say so clearly and unmistakably in the statute relating to the practice of law and rendition of legal services by individuals. It did not say so, and in my opinion there is not to be found in that section of the Penal Law any provision against the rendition of such services by an individual. We think the same idea is emphasized as in Section 280, that an individual who is not admitted to practice must not assume the character of an attorney at law. He is forbidden to practice or appear "as an attorney at law or as an attorney and counselor at law" or to make it a business to practice "as an attorney at law or an attorney and counselor at law" or to hold himself out to the public as being entitled "to practice law as aforesaid or in any other manner" or "to assume to be an attorney or counselor at law." But there is nothing which can fairly be regarded as indicating an intention to abolish an existing and widespread practice and to prevent a layman as such and without any simulation of or pretense to the character of an attorney from drawing a simple instrument as instructed by his customer and not involving or predicated upon any legal advice then given.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A. S. M. E. affairs.

Announcement

The Publication and Papers Committee of The American Society of Mechanical Engineers desires to afford members of the Society every opportunity to express themselves on the conduct of the Society and on other matters related to its affairs. Owing to the infrequency of meetings, communications to the editor of MECHANICAL ENGINEERING seem to offer the most prompt and direct means of placing the views of individuals before the entire membership. The Committee desires to encourage the writing of such communications as one evidence of the interest of the members.

Having in mind the reasonable limitation of space it is the intention to publish all such communications submitted. Where the communication cannot be published in full the author's name and address with a quoted sentence or a synopsis giving the purport of the letter will be published. It will be assumed that members will write in a terse and considerate style appropriate to our publications.—EDITOR.

Federated American Engineering Societies

TO THE EDITOR:

To be successful the Federated American Engineering Societies must be an instrument of service. Any engineering society that approaches the question from any other point of view is bound to be both disappointed and destructive. Manifold benefits will surely be derived by the member societies, but they are merely the rewards of service.

There is so much to be done for the public weal that only engineers can do that there can be no choice for you and me as to our participation or non-participation in the Federation. If we include ourselves among the "recreated engineers" of the present it all comes down to a question of choosing the most effective instrument of service. The world's experience amply shows that there is only one such instrument—union.

The reputation for indifference to and ineffectiveness in public affairs long since achieved by engineers is not of their deliberate choosing. Their aggregate effort is probably as great as that of many other professional classes. The principal difference lies in the fact that the engineers' efforts have usually been "out of phase." The Federated American Engineering Societies is essentially a synchronizer.

Many engineering societies will find that the constitution now drawn up will not conform to their ideas in all respects. No set of men is wise enough to draw up an instrument that will find universal approval. Let those who raise objections remember (*a*) how easy it is to object; (*b*) how easy it is to let petty complaints divert the mind from the master principle. This is a time for getting together. If we wait for a perfect constitution we shall always remain apart. Besides, a bad constitution will reveal itself in operation, and the cure is plain.

Some local societies think that in the Federation idea lies loss of identity. Let us not forget that there are two kinds of identity, one of which is "gladly lost." As for the other, it is strengthened by broad association, guidance and sustenance. No one has observed that the suckling child loses its identity, nor the adult who in his temporary weakness is revived by a blood transfusion.

To the Joint Conference Committee it may be said that adverse action by many of the societies should not be considered as a defeat of the project. There will be many societies which genuinely cannot adopt the plan without reservations in certain relatively small respects. If such reservations do not lessen the responsibility of such societies to the Federation then they should be counted among the members and the necessary adjustments can be made by the new organization at its leisure.

M. O. LEIGHTON,
National Service Representative,
Washington, D. C. *Engineering Council.*

Select Strong Men for Directors of the New Federation!

TO THE EDITOR:

If an engineer believes that his profession should take an active part in public affairs and that it should organize effectively to protect its own interests, then he should lose no opportunity to urge general approval of the plans for the new Federation of Engineering Societies to be known as the American Engineering Council, which were presented at the Washington conference of engineers held on June 4 and 5.

Criticism of the machinery of the new organization is no longer pertinent or helpful. Nor is the detail of the machinery anyway quite so important as has been sometimes claimed.

The question of greatest importance is: How and by whom is this new machinery to be operated? What the new American Engineering Council is able to accomplish for the benefit of the profession and the public will depend very much on the quality of the thirty-odd engineers who are to be members of what may be called the Board of Directors of the profession.

Will the members of the local engineering societies and of the national societies take a live interest in the selection of the delegates who are to make up this new body? Will they use their influence to have men chosen who are able and willing to make the personal sacrifices of time and money necessary to attend the meetings of the Council, and who have in addition the ability and breadth of mind to enable them to judge wisely in all matters submitted to them?

It is upon the answers to such questions as this that the success or failure of the new plan for coöperative effort by various branches of the engineering profession will turn.

The experience gained in the operation of the present Engineering Council during the three years since its establishment has proved that there is real and important work to be done. It is work that demands time, energy and ability. It requires no small outlay of money, which the profession must furnish; but the profession must see to it also that men are selected for this position not because of a desire to honor some personal friend, but solely because the voters know the candidate chosen to be competent for the job and willing to faithfully discharge its obligations if elected. CHARLES WHITING BAKER.

New York, N. Y.

Machine Tools—What Are They?

TO THE EDITOR:

At a meeting of The American Society of Mechanical Engineers in 1885 one of the subjects for discussion was the power requirements for machine tools. In the course of this discussion one of the speakers, complaining about the indefiniteness of the question, said, "What a machine tool is, is slightly in doubt," and this question has been with us ever since. The dictionaries define it as a machine that uses tools, and the Custom House officials have accepted this and include woodworking tools under this classification. Users, dealers and manufacturers, however, do not accept the definition and the whole subject is as far from being settled as it was in 1885.

The question of the proper use of any word proceeds along lines of advocacy of certain use by various men, based on derivation, literal interpretation, or ancient authority; while the general acceptance of these words by those who have frequent occasion to use them is the actual test of their proper use. "Whatever is, is right," is sound etymological doctrine.

Edward H. Knight in his mechanical dictionary, published in 1872, gives the following definitions:

> *Machine:* An instrument of lower grade than an engine, its motor being separate. It is distinct from a tool, as it contains within itself its own guide for operation.
>
> *Machine Tool:* A machine in which the tool is directed by guides and automatic appliances. Among tools (sic) of this class for metals are lathes, punches and shears. Machine tools for wood are sawing machines, planing machines, etc.

It is the habit of dictionary makers to copy each other, and it is not improbable that our present-day dictionary interpretation of the word is derived from the above. It must also be said that to define a machine tool as a tool-using machine is a very natural and obvious definition to give. There is some doubt, however, if the original and common use of the words is as indicated above.

Mr. Cameron Knight, author of The Mechanician and Constructor, published in 1869, in the course of a very complete definition of shop terms, includes the following:

> Tools include every implement small and large, simple or complex, which is used to produce or operate upon the work in the course of progress. A center punch in a turner's pocket is a tool, and the lathe before him is a tool.

It is an easily verified fact that in the text and advertising columns of the early mechanical papers such as the *Scientific American* (1846), the *Mechanics' Magazine* (1836), and the *American Artizan* (1862), the term "machine tools" is used but seldom, and then exclusively by editorial writers. The first observed use was in 1862. "Tools" is the word that was in universal use during the Civil War period to indicate what we now call machine tools. Advertisements for the sale of the after-war surplus were either under this caption or under the heading "machinist's tools." This use of the word persists into the eighties. In fact, in the discussion referred to in the opening paragraph, the word "tools" was not infrequently used. There can be no reasonable doubt, therefore, that although the expression "machine tools" was at least recognized as far back as 1860, "tools" was the word in common and everyday use until the eighties.

In 1879, Frederic B. Miles formed a company with the name "Machine Tool Works." This is the first noted instance of the use of this term by a shop man. The above company advertised the manufacture of steam hammers, planing machines, and lathes.

On first thought we may be inclined to define a machinist as a machine-using workman, and a machine shop as machine-using shop, but this definition will admit weavers and textile mills to these classifications. It is evident that a machinist is a machine-*building* workman, and a machine shop is a shop that builds machinery. By an analogous reasoning a machine tool is not a tool-using machine, but a machine-building tool; that is, a tool or machine for building machinery. This definition conforms to the best modern definition of the term, viz.: Machine tools are machines which, when taken as a group, will reproduce themselves. This excellent definition has the disadvantage of being general rather than specific, and as a secondary definition I would suggest the following: A machine tool is any metal-working tool whose waste is in the form of chips. This is specific and can be easily applied to any particular machine. It is not necessary to define a metal "chip," but it may be advisable to recall that the sparks from a grinding machine are chips, very small chips to be sure, but chips. This definition excludes sheet-metal-working machinery and metal-forming and forging machines, but these are probably not classed as machine tools by a majority of shop men, and in any case it is necessary to draw the line somewhere, and this seems to be the best place.

This classification will then include all metal-cutting machinery whose action is a progressive cutting away of surplus stock, a gradual reduction in size until the finished dimensions are reached. A considerable part of such machines use a single-point cutting tool, and in these cases as well as the case of milling cutters the angles of these cutting tools are of common interest to machinists and machine-tool builders. The design of these machines has progressed along similar lines and the introduction of single-pulley drives with all-geared feeds and speeds has found ready acceptance among manufacturers. Lathes, milling machines, grinders, drills, boring machines, etc., are now so equipped.

A press, when used for piercing sheet metal, has very little in common with any of the above-mentioned machines. They are all metal-cutting machines, and here the similarity ceases. The metal is not in the same form, and the cutting tools have nothing in common with other metal-cutting tools as to construction or cutting angles. When a press is used for forming it has nothing in common with lathes, etc., other than the fact that they are all metal-*working* machines, such as power hammers, bulldozers, swaging machines, etc.

If we admit that the terms "machine tools" and "metal-working machinery" are coextensive, or go further and define a machine tool as a tool-using machine, we are then confronted with the lack of any definite and restricted term to apply to 90 per cent of our machine-shop equipment. It seems desirable to have such a term, inasmuch as a steam hammer has no more in common with a lathe than a blacksmith has with a machinist. It is probably a fact that 90 per cent of those who are variously engaged in the machine-tool industry will say that a universal grinding machine is a machine tool, but would not be quite as sure about a punch press, a steam hammer or a mowing machine, and this great majority of opinion should be the deciding element in this question of terminology.

L. L. THWING.

Boston, Mass.

Fiber Stress in a Square Plate

TO THE EDITOR:

In your April issue, p. 249, H. W. Sibert gives a method for finding the fiber stress in a square plate supported on the edges and loaded with a uniform load normal to its surface. I believe his method of finding this stress is incorrect, and that therefore his results are incorrect. He finds a bending moment of constant intensity in a direction at right angles to a rectangular axis through the center of the plate and equal fiber stress in that direction from center of plate to the middle of a supporting edge. It is not possible for any stress to exist parallel with the support at any point along that support, for stress, of necessity, means a curving of the plate; and no curving could take place while the plate is in contact with its straight and rigid support.

It is further incorrect to combine these two rectangular stress intensities, as Mr. Sibert has done, by taking the square root of the sum of the squares, for the diagonal of the square on which the combined force acts is increased (over the side of the square) in exactly the same ratio, so that the intensity would remain exactly the same in a diagonal direction.

In my book "Concrete," p. 287, I have given a method for solving the problem which is practically correct and about as simple as it can be made. In that solution two rectangular strips are taken across the middle of the plate, each one unit wide. The load on the middle square unit is equally divided between these two strips, but other intersecting strips take less and less of the load w, because, as the edge is approached, these strips cannot bend and take their equal share of the load. The load on the critical strip is the full w per unit at the support, and the curve of increase from center to support is assumed to be a parabola. This gives $7wL^2/96$ as the bending moment in the middle of the plate against Mr. Sibert's value of $wL^2/16$.

EDWARD GODFREY.

Pittsburgh, Pa.

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The Federated American Engineering Societies

Steps to Be Taken to Complete the Organization—Its Effects on the Work of Existing Local and National Societies

E. S. CARMAN, CHAIRMAN OF LOCAL SECTIONS COMMITTEE

THE Federated American Engineering Societies, organized in Washington June 3 and 4, marks one of the milestones in this, the engineering societies' epoch of organization.

It was apparent several years ago that in order for the engineering profession to continue to occupy a high rank in the catalog of professions, a means must be provided whereby all engineers, regardless of branch, could act together in considering matters of common interest to the profession at large and also to the public.

In the organization of the Federated American Engineering Societies the means has been provided. Therefore, without further statement as to the desirability of having such an organization, let us accept the facts as they are, viz., that the organization has been started, and that it is now more important to discuss what will be necessary to complete its organization and properly begin its activities in order that the Federation may be most effective in representing the interests of the engineers of the country.

The organizing conference at Washington placed in the hands of the Joint Conference Committee of the four Founder Societies and Engineering Council the *ad interim* authority until the organization should be fully completed. The next steps then to be taken are:

1 Consideration by local, state, regional and national societies and applications made for charter membership (all organizations invited to attend the Washington Conference are eligible) in the F. A. E. S.
2 Appointment of societies' representatives on American Engineering Council.
3 Conference of representatives to elect officers and complete organization.
4 Activities to be immediately begun by the officers and organization.

As an obligation which they owe to the profession, every engineering society in the United States should be fully acquainted with the constitution and by-laws of the F. A. E. S. and be prepared to make an early decision and become a charter member.

The effect that the F. A. E. S. will have on other societies, and how it will affect their present activities can best be summarized as follows:

Local Societies
1 Participation and expression in all national, state or regional affairs of interest to the engineering profession.
2. Assistance in local affairs (when desired) by the national organization.
3. Greater local activities by complete local affiliation of all local and national societies' local sections.

State Societies
1 Participation and expression in all national, state or regional affairs of interest to the engineering profession.
2 Assistance in state affairs by local, regional and national societies.
3 Uniform recommendation in the various states regarding license and registration laws, road building, public utilities, etc.

Regional Societies
1 An opportunity to assist local, state and national societies in matters of common interest.
2 Receive assistance from local, state and national societies in furthering matters of common interest.

National Societies
1 Provide a place through local affiliations where the individual members may meet and have an opportunity of expression in local, state and regional affairs.
2 Provide a means of further coöperation with all engineering societies and coördinating such activities as
    Standardization
    Research
    Education
    Ethics
    Legislation
    National public engineering projects.
3 A more complete coöperation between the several national societies.

The question as to whether or not the engineer desires to have a part in local, state and national public affairs is answered today in the affirmative, as we now find him so engaged. He has accepted his local citizenship responsibilities and is now desirous of having a means of expression in exercising his national citizenship obligations.

The engineer today is alert and aggressive and eager to accept the responsibility that comes with the greater activities.

The F. A. E. S., as stated before, is only a beginning of society coöperation and of necessity must proceed cautiously and yet effectively.

Is it too much to expect that as the years come and go and complete confidence has been established by successful performance, the final result will be: One large, all-inclusive American Engineering Society with national professional branches and organizations, local branches and clubs in all of the many cities, and only one payment of dues by the members to entitle them to all privileges of local, state, regional and national organizations?

E. S. CARMAN,
A. S. M. E. Representative,
Cleveland, Ohio. *Joint Conference Committee.*

Wage Increases Not Necessarily on a Straight-Line Curve

Early this summer Mr. Charles Piez, Mem. Am. Soc. M. E., submitted to the United States Railroad Labor Board, for the Board of Directors of the Illinois Manufacturers' Association, a statement of principles which he believed should prevail in deciding upon wage increases. "The practice," he says, "of basing wages on the cost of living, without taking into account the work performed for the wages is, in our opinion at the very bottom of the present disturbed and unsatisfactory labor condition. . . . If we accept the figures submitted that $1700 represents the lowest subsistence level and $2500 the lowest comfort level for an American family, and base the scale of wages in the transportation service on the assumption that every man engaged in this service, no matter where he lives, whether married or single, is entitled to a wage based on a scale with those figures as minimums, would it not be fair to assume that every wage earner in every character of employment everywhere in this country is entitled to a scale based on that same minimum?"

Mr. Piez contends that if such a universal demand were made and acceded to, based on a straight time basis rather than on a production basis, the farms, the mines and the industries would be wholly unable to meet the cost. "Wages can't be paid unless they are earned and we can't get out of the common pot more than we put into it."

He further says there is undoubtedly justice in the demand for an increase among railroad workers and that there is no intention of arguing against a fair increase; and that particularly there should be an increase among the lower-paid classes as the high cost of living has affected them the most adversely. Nevertheless, "The divorce of wages from production has been one of the calamities of the war, for it has created in the mind of the wage earner the delusion that irrespective of output, performance, or character of service rendered, he is entitled to live on a certain scale. Statisticians spend their time in developing elaborated lists of family requirements, instead of determining how wage increase based on these requirements can be paid.

"And so it happens that during the most critical time in the industrial history of the country, when the consumption of commodities has expanded, and world production of commodities has been greatly impaired, we have established a shorter working day, have abolished piece and premium forms of payment, and have imbued the wage earner with the idea that he is entitled to a good living if he but spends eight hours at a job."

Two Attitudes on The Department of Public Works

As a member of the National Chamber of Commerce, Engineering Council was instrumental in that having that body present to its member organizations a ballot designed to record the attitude of the Chamber on the question as to whether or not a Department of Public Works should be brought into being.

The propositions, which were submitted to 478 organizations, and the results of the balloting on each were as follows:

1 Shall a Department of Public Works be established by the national government?—827½ votes in favor—549½ votes opposed.

2 Shall a Department of Public Works be established by a suitable modification of the existing Department of the Interior, excluding therefrom the non-related bureaus and offices and by change of name from Department of the Interior to Department of Public Works?—676½ votes in favor—639½ votes opposed.

3 Shall a Department of Public Works be established by creation of an entirely new department?—283 votes in favor—993 votes opposed.

In accordance with these votes, the Chamber is not committed to either the first or the second proposition, for the reason that two-thirds of the votes cast were not in favor of either. As to the third proposition, the Chamber is placed by the voting in a position of opposition; for more than one-third of the total voting strength of the Chamber was recorded and more than two-thirds of the votes thus cast, representing more than twenty states, were recorded in opposition.

In this connection it is gratifying to note the interest of men of affairs in this movement as reflected in one of the planks of the Republican platform. As this plank was initiated and brought about by engineers to its present degree of acceptability it will be of interest to quote its phraseology:

> We advocate a thorough investigation of the present organization of the Federal departments and bureaus with a view to securing consolidation, a more businesslike distribution of functions, the elimination of duplication, delays and overlapping of work and the establishment of an up-to-date and efficient administrative organization.

It is further understood in Washington that the Smoot-Reavis bill proposing a general reorganization of all departments along the lines suggested by the engineers for the Department of Public Works carries the provision that the first department to be so reorganized will be the Department of the Interior and its conversion to a Department of Public Works.

The Outdoor Power Plant

In the May issue of MECHANICAL ENGINEERING, p. 307, reference was made to an article on the practicability of the outdoor generating station, written by H. W. Buck, and published in the *General Electric Review* of March, in which the advantages of such construction were pointed out. There has now appeared in the May number of that review an article by Henry G. Reist, Mem. Am. Soc. M. E., calling attention to the difficulties to be encountered in the outdoor plant, one of the most serious of which is the necessity for the construction of the generators so that the windings will be kept dry and at the same time will be properly ventilated. He says:

> It has always been assumed that the windings of electric machines should be kept dry. It is difficult to maintain this condition and get proper ventilation in a generator exposed to the weather, without special construction and additional expense. If the generator is allowed to become cold when not in use there is likely to be condensation of moisture on coils under certain atmospheric conditions. To prevent this, many pieces of electric apparatus are provided with special heaters of some sort to keep the machine warm when it is idle.
>
> In case machines are exposed in very cold weather there is danger of difficulty from the oil becoming too thick. This danger would apply especially to self-oiling thrust bearings placed at the top of the machines, since these might heat at starting before the oil became sufficiently thin to circulate freely.
>
> Automatic stations, which operate without an attendant, should be inspected from time to time by a patrol. In case of very cold or disagreeable weather it is probable that such inspection would be superficial.
>
> On synchronous machines placed out of doors the installation of exciter units presents difficulties. In small machines exciters are frequently belted and on larger machines they are either direct-connected or driven by motors. Whatever arrangement is used, considerable inconvenience will be caused by lack of a protecting roof. In some installations these parts, together with the governing mechanism, can be placed in chambers in the masonry below the generator floor; but in other cases, due to danger from high water, this could not be done, and with small low-head machines such masonry construction would add considerably to the expense.
>
> I would suggest that instead of building special weatherproof out-of-door generators, standard generators be used, and that simple, inexpensive semi-portable shelters be erected over them. In the case of several machines in one installation, I think it would be desirable to have a low house extending over the line of machines, with a gantry crane bridging the house, the house, or at least its roof, to be made in sections which can be moved on a track parallel with the line of generators to telescope with the roof over the adjacent generator, or each generator to be covered with a unit roof which may be lifted bodily from its place by means of a crane. I believe there would be sufficient heat generated to keep such a powerhouse comfortable, and that by suitably arranging the ventilators warm air could be passed over any generator that was not in use, thus overcoming the difficulties which might be experienced with the generators out of doors.
>
> The simple house suggested would provide a shelter for the exciters, waterwheel governors, and the patrol on his visits, and would seem to offer all the advantages of a more expensive power house. It is probable that a protecting house, as described, could be constructed for little more than the extra cost of a generator exposed to the weather.

Across the Continent by Land and Air

The first transcontinental convoy of the Motor Transport Corps which crossed from Washington, D. C., to San Francisco, Cal., last summer has given, as shown in the paper presented by Lieut. E. R. Jackson, Mem.Am.Soc.M.E., at the Spring Meeting of The American Society of Mechanical Engineers, a large amount of valuable information both as to the state of the roads and as to the various makes of automotive equipment and methods of handling them.

It is gratifying to find that an earnest effort is being made to add to this store of knowledge. On June 14 the second transcontinental convoy left the East on its long, and at times weary and dangerous, journey to the Pacific coast, and we may expect to hear in a few months how the experience of last year helped on the present trip.

An interesting enterprise is now being carried out in another direction also. There were two long flights made last summer: one from Long Island to the Pacific and back, carried out in the form of a race, and the other, the "flight around the rim," which was intended as a test of endurance of machines and accessories. Both of these flights gave a considerable amount of valuable information and showed what can be done by the Army pilots.

This summer conditions have on the whole been less favorable to Army aeronautics, but an attempt is being made to carry out an all-air flight from Long Island to Nome, Alaska, which is of interest not only because of the great distance to be covered, but because in its final laps this flight will probably become a precursor of a regular system of communication by air which will bind more closely to this country a wealthy but somewhat neglected possession.

In this connection, attention may also be called to the vigorous extension of the net of aerial mail transportation by the Post Office Department, which has recently asked for bids for several new routes which will afford air delivery of mails to towns in the South and West.

Making Houses Truly Livable

Taking our living conditions all around, it would appear that while we may have progressed in some ways during the last 50 or 100 years, and have learned to keep our houses clean (improved sewerage), supplied with good water, and efficiently lighted, in other directions we have not made very much progress as compared with the houses of the times of the first white settlers on this continent.

It is generally recognized in anthropology that one of the greatest milestones in the development of the human race was passed when men learned to heat their houses. This is what made the habitation of the so-called moderate-climate zone possible, and it is there that most of the progress of the human race has been achieved.

The human race has not, however, passed the next stage of development in this direction, which is to make our houses and offices truly livable the year round. We have learned how to combat cold, but not how to handle heat,—at least we have not yet learned the wisdom of actually doing it.

One of the reasons why tropical countries are so hard on the white man as to make his development in those sections a very uncertain problem, is because a white man cannot live and preserve his efficiency year in and year out at a temperature above blood heat. Even in the so-called temperate zone we have conditions for several months in each year which very decidedly reduce the efficiency of our working forces and sometimes quite harmfully affect the health of our population.

If we are heating our houses in the winter, why, with our present knowledge of refrigeration, can we not cool them in the summer? As a matter of fact, this has already been done in numerous instances. Thus, a refrigerating plant was installed in the New York Stock Exchange a few years ago, with the result that a temperature of 65 deg. fahr. is maintained on the floor of the exchange no matter what may be the outside atmospheric temperature.

The development of the small automatic refrigerator for preserving perishable goods which works practically without requiring any attendance, bears an important promise for the future. And if automatic refrigeration can be installed to keep meat and butter fresh and clean at a cost of a few cents a day, there is no reason whatsoever why a similar but larger machine could not be installed to do the same service for human beings, who need a constant temperature to be in good condition just as much as perishable foods. This applies especially to places like hospitals, offices, etc.

At least two obstacles have in the past held back the general introduction of cooling systems. The first is the higher relative cost and expense of operation of a refrigerating plant compared with a heating system, which is offset in part, however, by the fact that the temperature range required in cooling is only about half that required in heating. The second is the difficulty of dealing with the humidity often present in the warm air and which, at reduced temperatures, becomes exceedingly uncomfortable. If the air is cooled its vapor is condensed, and unless proper care is taken it will collect on the cooler surfaces of a building. However, ways have already been found to deal with this side of the problem and no doubt other ways will be found as soon as an earnest effort is made to apply artificial house cooling on a wide scale.

Probably the chief and real obstacle to the general introduction of cooling systems in buildings has been the fact that people *can* get along without them by the use of such local expedients as electric fans or arrangements for the proper ventilation and circulation of air. People cannot get along without heating systems, however, and they accordingly have become universal and have reached their high state of efficiency.

The American public, at least, is accustomed to having the things it wants regardless of cost, as evidenced by the high percentage of the population who have secured automobiles within the period of a few years, and as the development of our buildings progresses in the matter of comfort and convenience, there will undoubtedly be a greater demand for the same degree of comfort during the warm weather as during the cold weather, and we may expect the mechanical engineer eventually to have a large and fertile field for his abilities in the design, construction and operation of small cooling systems, comparable in cost and size to our small heating systems.

Ten Ways to Kill a Branch of an Engineering Society

(1) Don't come to the meetings. (2) If you do come, come late. (3) If the weather doesn't suit you, don't think of coming. (4) If you do attend a meeting, find fault with the work of the officers and other members. (5) Never accept office, as it is easier to criticize than to do things. (6) Nevertheless, get sore if you are not appointed on the Committee, but if you are, do not attend Committee meetings. (7) If asked by the chairman to give your opinion on some matter, tell him you have nothing to say. After the meeting tell everyone how things ought to be done. (8) Do nothing more than is absolutely necessary, but when members roll up their sleeves and willingly, unselfishly use their ability to help matters along, howl that the branch is run by a clique. (9) Hold back your dues as long as possible, or don't pay at all. (10) Don't bother about getting new members. "Let George do it."—*The Engineering Institute of Canada.*

Listing Forms for Directory of Consulting Engineers in 1920 Volume of Condensed Catalogues

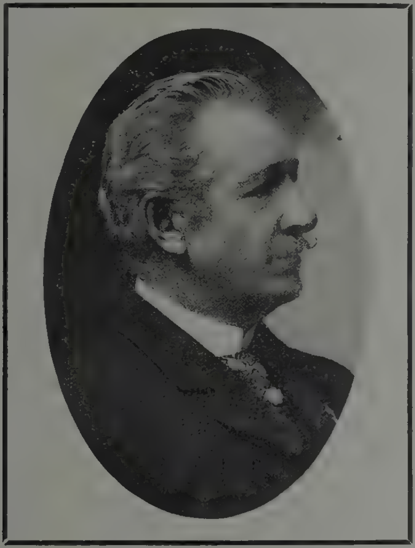
It is planned to further extend and improve the Directory of Consulting Engineers in the forthcoming issue of the Condensed Catalogues, and members actively engaged along consulting lines are invited to write to the Society for special forms covering listings in this section of the volume. In developing the Directory it is particularly desirable that all the specialized lines of practice should be indicated so far as possible, and the coöperation of the members to this end will be welcomed.

CHARLES ETHAN BILLINGS

Charles Ethan Billings, chairman of the Board of Directors and former president of the Billings & Spencer Manufacturing Co., Hartford, Conn., died on June 4, 1920, after a long illness.

Mr. Billings was born in Wethersfield, Vt., on December 5, 1835. After receiving a common-school education, he served a three-year apprenticeship in the gun department of the machine works of the Robbins & Lawrence Co., Windsor, Vt. In 1856 he entered the employ of Colt's Patent Firearms Manufacturing Co. as a toolmaker and die sinker. During the early stages of the Civil War he was employed in the gun factories of E. Remington & Sons, Ilion, N. Y.

From 1863 to the close of the war, Mr. Billings was making drop forgings for the U. S. Government. He was one of the first men in the country to use drop hammers in the manufacture of arms, and it was he who perfected the forgings that were universally used in the manufacture of pistols for many years afterward.



CHARLES ETHAN BILLINGS

When the war was at its height and many large contracts for pistols were coming in from the Government, it was found necessary often to run the shops at night. The continual pounding of the drop hammers was a source of great disturbance to the surrounding neighbors and they voiced their indignation in no uncertain terms. It was not long before a delegation composed of the mayor and some prominent citizens waited upon Mr. Billings to complain of the noises that issued nightly from the shop and to demand that they cease. Mr. Billings stated briefly that he had orders to run his shop night and day until the contract was completed. "Orders," exclaimed the mayor, "Be pleased to understand, sir, that all orders in this town come from me. I should like to ask you, sir, who gave you these orders?" "My orders," replied Mr. Billings, "come from Abraham Lincoln." The noisy drop hammers continued their work until the peace of Appomattox.

At the close of the Civil War, Mr. Billings returned to Hartford where he became superintendent of the Weed Sewing Machine Co. for three years. In 1869 the Billings & Spencer Co. was organized, C. M. Spencer being the other member of the firm. The company was incorporated to manufacture drop forgings and develop various improvements and inventions in the numerous small parts of machinery which, through the inventive genuis of Mr. Billings, became of great value to the world. He was the inventor of a score of articles now in general use such as drills, chucks, pocket knives, wrenches, etc.

Mr. Billings was a life member of the Society, and one of the first to join the organization, which he did in 1880. He served as vice-president and president from 1893 to 1895.

He was also very active in the civic affairs of Hartford, where for twelve years he was president of the Board of Fire Commissioners. For several terms he served as councilman and as alderman. He was president of the State Savings Bank of Hartford and trustee of the Hartford Trust Co. He leaves a wife, two sons and one daughter.

The Technical Library As Related to Plant Efficiency

Never in the history of industry in the United States has so forceful an effort been directed toward the mental and physical elevation of the individual, with the ultimate purpose of greater and improved production through increased efficiency, as at the present time. Never has so much intensive attention been devoted to the fundamental and advanced training of executives and labor in general in industrial establishments as in these days when economic conditions demand a most comprehensive understanding of the technicalities that complex production. From president to apprentice, thorough knowledge of the task in hand is an absolute essential to the success of the industry. Even the unskilled laborer must be more than a machine performing routine work merely as routine, without intelligent comprehension of, and interest in, his labor.

Upon the uncontested premise that greater efficiency means increased and better production and that efficiency is the result of intelligent interest, study and knowledge, rests the claim that the industrial establishment which invests in the installation of a technical library within its plant, will soon outstrip its competitors who have not had the foresight to adopt the plan. The American Library Association, coöperating with the Special Libraries Association, two national organizations of high standing, plans under its enlarged program to provide estimates, outline the selection of books best suited to the industry, and explain the working system that will bring the best results,—in fact, to coöperate in every possible way with the concern which is to have the library installed.

"It is true," declared a famous university professor, "that knowledge is power, but the best kind of knowledge does not consist of knowing facts, but in knowing where to go and find facts when you need them."

The progressive executive knows the value of forwarding the mental and physical welfare of his employees and realizes that their condition is reflected in the condition of his industry. He knows that the higher the plane of the workman's intelligence, the worthier his output, and he adopts every feasible method of promoting that efficiency which is derived from mental advancement. He recognizes that by study the worker becomes more valuable to himself and to the concern, and he opens every possible avenue that leads to that end. Once the interest in serious, purposeful reading is awakened, it continues, the reader attains a higher position, his work is bettered and the general welfare of the industry enhanced.

It is therefore to the great advantage of the employer that the habit of reading and study be encouraged to the fullest extent, and to this end the technical library is the best possible coöperative agent. But the technical library is not designed for the benefit of the working forces alone. While it is a wonderful medium for the promotion of increased efficiency through study and comprehensive reading, it is the source, if properly conducted, of information for the executives as well. It is the fountain head to which they can turn for a solution of practically every problem that presents itself; it is the clearing house from which are available the minutest details of shop and office direction; it is the source of time- and money-saving knowledge, obviating the necessity of experimenting, with its waste of material, effort and financial outlay. It contains treatises on the most modern methods, the newest appliances and devices, system and management—in fact, the yield of the best brains of many persons for the instant use of the individual.

News and Notes of The Federated American Engineering Societies

Technical Club of Dallas Joins the New Organization

One of the outstanding features of the Organizing Conference was the enthusiastic interest of the delegates representing the local, state, and regional organizations. It is not surprising, therefore, that these local organizations should be among the first to apply for membership in The Federated American Engineering Societies. Already the Technical Club of Dallas has made application and in doing so filed its claim as being the first local organization to apply. It thus evidenced its enthusiastic desire to take an active part in the formation of the Federation. Congratulations to the Technical Club of Dallas.

Engineering Council Gives Its Endorsement to the Federation

At its last regular meeting held on July 17 Engineering Council passed resolutions endorsing the new Federated American Engineering Societies and offering its assistance in the conduct of the work necessary before the new organization can function. Inasmuch as the constitution of the Federation calls for the creation of an American Engineering Council with representatives from the various member societies, the action of the present Council is one of great importance, as to all practical purposes it means that the American Engineering Council is now functioning with six societies backing it. The resolutions of the Engineering Council follow:

Voted, That Engineering Council heartily endorse the plan of organization of The Federated American Engineering Societies and the American Engineering Council, adopted by the Organizing Conference of technical societies in Washington June 3 and 4, and authorize its Executive Committee to proffer and perform on the part of Council such assistance as may be practicable in completing the work of the Organizing Conference of the Joint Conference Committee of the Founder Societies in establishing the American Engineering Council.

Voted, That Engineering Council authorize its Executive Committee to deal with any question of coöperation with the Joint Conference Committee of the Founder Societies, relating to the permanent organization of The Federated American Engineering Societies, which may come up during the summer.

Voted, That the Secretary be instructed to invite to future meetings of Engineering Council delegates of the societies participating in the Organizing Conference in Washington, June 3 and 4, and editors of technical journals who may be interested.

Three More National Societies Favor the Federation

The last issue of MECHANICAL ENGINEERING carried the announcement that The American Society of Mechanical Engineers were the first to voice their intention to join the newly organized Federated American Engineering Societies. Since then three other national engineering societies have met in convention and favorably considered the question of also joining the new organization.

At the annual meeting of the American Institute of Chemical Engineers held in Montreal June 28th-July 3rd, the question of the Institute becoming a member of The Federated American Engineering Societies was discussed and referred to its Council for definite action at its meeting on July 25th.

The report of delegates to the Organizing Conference was read at the meeting of the Board of Direction of the American Institute of Electrical Engineers at the annual convention at White Sulphur Springs, W. Va., June 30 and the following resolution adopted:

RESOLVED: that it is the sense of this Board that the American Institute of Electrical Engineers should join The Federated American Engineering Societies, but that as there is a small attendance at this meeting and a new Board will be constituted, commencing with the administrative year on August 1, action be deferred until the August meeting of the Board and that a letter be sent to the members of the incoming Board, with a request that they give careful consideration to the matter and be prepared to act at the next meeting.

The report of the delegates to the Washington Organizing Conference was read at the meeting of the Board of Direction of the American Institute of Mining and Metallurgical Engineers on June 25, was favorably discussed and referred to the Finance Committee to devise and report on means for meeting the financial requirements.

The report of the delegates to the Washington Conference representing the American Society of Civil Engineers will be presented at the Annual Convention of that Society, at Portland, Ore., August 10-12, 1920.

Some Technical Press Comments on the Washington Conference

The youngest profession has voluntarily accepted its responsibility in human affairs and is now reaching forward to a career of essential service. This is unmistakably the meaning of the action of the organizing conference of engineers held in Washington, early last month. . . . the object of the Federated American Engineering Societies is to give expression to the exalted motive of service for the public good. It stands to the credit of the profession that this was done without a dissenting vote, although the forces of materialism were active and vigorous in expressing their opposition in debate.

Truly one of the great milestones in engineering history has been passed. From now on the youngest of the professions will begin to wield a power in public affairs which is destined to be a controlling factor in the working out of economic and industrial conditions.—*Industrial Management*, July, 1920.

Seldom does the habitué of technical and general gatherings absorb so many inspirational thoughts tumbling fast through a medium electrified with a sharp clash of intense purpose as at Washington last week. This alone would mark the recent organization of The Federated American Engineering Societies. Not only were the brief and pithy addresses from eminent engineers in various walks of life full of allusion to the widespread value of engineering thought and achievements, but even the sharpest discussion was based entirely upon the best and most effective method of giving service. Service was the keynote—not struck by the first speaker of the meeting and then forgotten, but animating the proceedings to the end.—*Chemical and Metallurgical Engineering*, June 9, 1920

This organization by engineers is one that will result in a large measure of good to the profession of engineering. It is a practical demonstration of views long and stoutly maintained by this journal and exactly in line with definite progress toward a closer and more valuable working association of engineers throughout the country.—*American Architect*, June 1920.

The greatest step, or at least the greatest potential step, in the history of engineering in the United States, was taken on June 3 and 4 at the Joint Engineering Conference in Washington when the Federated American Engineering Societies was organized. This body was created for the avowed purpose of public service. The American Electrical Railway Engineering Association should assume its full share of coöperation in the federated societies.—*Electrical Railway Journal*, July, 1920.

No gathering of engineers in America has ever quite equaled in potential importance that which took place at Washington, D. C., on June 3 and 4. With the entry into The Federated American Engineering Societies of the component organizations that are expected to support it, there would be 100,000 engineers banded together for public service and the advancement of the profession in the United States. It was intimated that the American Association of Engineers would continue to carry on in its own way. The outcome of this experiment in federation will be watched with the greatest interest by engineers in Canada. It is not unlikely that similar action will before long become a matter for serious consideration and discussion amongst technical men in this country.—*Canadian Engineer*, July 1, 1920.

The Federated Engineering Societies are to be congratulated on their recognition of the principle of publicity. When the engineering world shall speak out habitually and authoritatively through the professional and lay press alike, to recount its achievements, to outline its projects, and to tender its advice on all matters where it has knowledge and a collective concern, it will both perform an imperative duty and help individual engineers to gain the great degree of recognition, the high scale of remuneration, and the broad sphere of influence that should be theirs.—*Electrical World*, June 19, 1920.

One of the most important meetings of engineers that has been held in the United States, assembled in Washington, June 3-4, to take up the question of forming a federation of the engineering societies of the country. The importance of this conference can hardly be overestimated. It has been said of engineers that they cannot coöperate, or at any rate they do not, and that this has been the reason why engineers have not had the influence and standing in the community to which the importance of their professional work entitles them.—*Power Plant Engineering*, July 1, 1920.

Organization of The Federated American Engineering Societies was effected at the organizing conference of national, local, state and regional engineering and allied technical organizations at the Cosmos Club, Washington, D. C., June 3 and 4. Thus is brought into being the greatest national engineering society in the world.—*Mining and Metallurgy*, July, 1920.

In laying the foundation last week for a national federation of engineering societies, the Organizing Conference at Washington, D. C., took action which will add a new chapter to American engineering history. The two-day meeting of delegates representing more than sixty national, state and local societies .... was unique in its purpose in the widely representative character of its participants and in the spirit of coöperation and service which animated every session and which, at times, seemed to transform the delegates from mere technical men concerned chiefly with the details of engineering construction and design into apostles of a new order of professional solidarity.

Never before have engineering organizations throughout the country enjoyed the opportunity that is now presented to them of affiliating to secure united action.

The conference was truly remarkable in its representative character, as indicated by the list of societies and delegates........... Engineers have been criticised, and just so, for their professional aloofness. During the past decade or so the profession has become highly specialized and where, in former times, we had only "engineers" we now have civil, mechanical, electrical, mining, industrial, automotive, and scores of other classifications. This specialization has tended to segregate engineering into groups working more or less independently. At the conference, however, engineers of all kinds met and worked together.

The federation of engineering societies, as did the conference which created it, offers to technical men, for the first time in their history, an opportunity of presenting a *united* front on matters of civic and economic import.—*Engineering News-Record*, June 10, 1920.

June third and fourth were epoch-making days in the history of American Engineering. On those dates one hundred and twenty-three representatives of sixty-one engineering societies met at Washington and instituted an organization through which the united engineering talent of the country can function for the service of the public and the progress of the profession. The stage is now set, the program prepared in which the engineer is to take a larger part. Not a more active part, for his has always been the working role, but more prominence given to his part. Less work behind the scenes and in the supporting cast and more of the headlines. The engineer has been trained and used to think and do rather than talk. He has been content to be the servant of the administrator at a price—*Power*, June 15, 1920.

An epoch-making step in engineering organization was taken in the Washington conference of technical society representatives which decided upon the formation of a federation of these technical associations. This is the first all-embracing movement of the engineers to place their activities upon a full professional basis comparable with that of the other learned professions of law, medicine and the clergy; and as such is of the greatest importance. For a number of years the several larger national engineering societies have been affiliated through the Engineering Council and other channels, but the work thus done is limited in many ways. It is a happy development, therefore, that gives us the larger agency which is now assured.—*Coal Age*, June 10, 1920.

Increased prestige and opportunity for service came to A.A.E. out of the conference in Washington June 3 and 4 called by the Joint Conference Committee of the national technical societies. Little if any occupation of the field occupied by A.A.E. is contemplated by the Federation. On the one hand is the Federation composed of societies and created for the public good; on the other hand is the democratic organization of engineers devoted primarily to helping the individual engineer to get on in life. A.A.E. was apparently recognized as the servant of the profession in the welfare field. There can therefore be nothing on the part of A.A.E. but cordial good wishes to the Federation.—*Professional Engineer*, July, 1920.

An event of immense importance to the engineering world took place in Washington, June 3 and 4. The large number of great engineering organizations represented would alone stamp this meeting as of tremendous import, but the object sought places it above that of any engineering gathering ever held. If the plan projected becomes workable, the engineer will at last be given the recognition due him for his public-spirited, though hitherto too modest, service. The American people *need* successful engineers in public office, along with successful business men and manufacturers, as we called to your attention in our recent editorial: "Not Politics—But Common Sense." The American people need engineers to take active interest in the great national problems. The Engineers need the American people to take an interest in THEM—a human, urging interest. It was to bring about the satisfying of this mutual need that the Federation was first proposed.—*American Machinist*, June 17, 1920.

The Organizing Conference has met and fulfilled its mission.— But if the new organization undertakes to trespass on the jurisdiction of A. A. E., in a spirit of competition rather than coöperation. by duplicating the work that A. A. E. began and has continued with such marvelous success, then justification for the confederation is difficult to find. There is abundant room for two comprehensive organizations of engineers, provided that one busies itself with joint technical matters and the other with social. A. A. E. has avowed its purpose to adhere to the latter. For any other organization to become a competitor in this work would be an act to invite dissolution rather than consolidation, an act to inspire the belief that after all engineers learned nothing from their war experience.—*Engineering World*, July, 1920.

French Society Presents A.S.M.E. Honorary Membership to M. Rateau

THE Société d'Encouragement pour l'Industrie Nationale conferred Honorary Membership on M. Auguste C. E. Rateau at its meeting on May 8. In a letter of greeting to the Société, Past-President M. E. Cooley, who was in office at the time the Society conferred this award both on M. Rateau and on M. de Freminville, another of his countrymen, thanked the French organization for extending this courtesy to our Society. Dean Cooley wrote:

GENTLEMEN:

I have the honor to convey to the Société d'Encouragement pour l'Industrie Nationale the greetings of The American Society of Mechanical Engineers, and to express the great pleasure that our President and Council feel in the gracious coöperation of the Société d'Encouragement pour l'Industrie Nationale in conferring honorary membership in The American Society of Mechanical Engineers on M. Rateau, who, much to their regret, was unable to be present at our annual meeting in December, 1919, to receive the certificate of membership in person.

Permit me also to say that this willingness of our confrères in France to assume the responsibilities and perform the functions of a sister society in America roused in us anew the spirit of friendship which had its birth in the splendid service rendered America by your gallant and intrepid Lafayette.

It was our desire in conferring honorary membership on MM. Freminville and Rateau, in addition to recognizing men of great distinction in the profession of engineering to give France additional evidence of America's appreciation of your country and your countrymen in stemming the recent tide which so nearly overwhelmed civilization and which unchecked might have precipitated the world into another dark-age period.

In the belief that France and America will always be found standing together in the cause of right against wrong, in peace as well as in war, I have the honor to remain.

Most respectfully
(*Signed*) MORTIMER E. COOLEY.

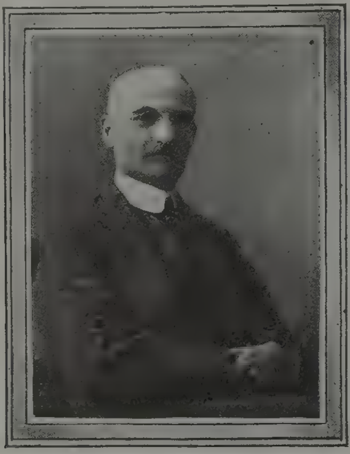
PRESENTATION ADDRESS OF M. DE FREMINVILLE

M. de Freminville, member of the Council of the Société d'Encouragement, and honorary member of The American Society of Mechanical Engineers, had been authorized by the Society to present at a public meeting of a great French technical association, the certificate of honorary membership which The American Society had conferred upon M. Auguste Rateau. In presenting the certificate to M. Rateau, and thereby conferring upon him Honorary Membership in the Society, M. de Freminville expressed the sentiments of American engineers in desiring to bestow this honor and reviewed the features of M. Rateau's professional accomplishments which led to his selection for honorary membership. He said in part:

MY DEAR M. RATEAU:

At this time when economic relations are so difficult to regulate among the countries of the world, and when there is so much clashing of individual interests, it is most pleasing to meet with men who desire above all to show their sincere attachment to France and their desire to collaborate with her. This is what the members of the Council of The American Society of Mechanical Engineers have desired to emphasize in conferring upon you honorary membership in their Society, a distinction extremely rare, and appreciated in America as the greatest that can be conferred upon an engineer at home or abroad.

This honor was bestowed upon you at the Annual Meeting of the Society, held on December 2 last in New York. During my recent visit to the United States I had the great pleasure of attending that meeting, and I remember well the reception which was accorded me, in the course of which I was requested to present this certificate to you.



M. AUGUSTE C. E. RATEAU

It was very natural that the choice of the Mechanical Engineers should fall on a man whose scientific accomplishments, as well as his record of practical achievements, are universally recognized. But permit me to assure you that our friends in America had the intention of honoring in you the singular genius of France for which they have the greatest admiration and the greatest respect.

The Americans, emboldened by the immense resources of their country, are remarkable for their great conceptions. Not being influenced by customary traditions, they have realized that the surest means of enhancing the value of their possessions is to appeal to the teachings of science. However, in spite of their love of doing things in a rush, they have not accepted conclusions without going back to their sources and without studying the works of the pioneers who have opened new fields of endeavor, and it is this policy which has made known to them the French men of science whose names are written on the walls of this society which so many of them have visited. Whatever the originality of their works, the Americans like to connect them with those of French scientists. They have never ceased to follow the development of science in our country and know that you have taken a great part in its development; that you are one of the pioneers in the manufacture of steam turbines and turbo-compressors and high-pressure centrifugal pumps; that you are the author of rules and formulæ for the steam flow through orifices of various forms and the originator of methods for the calculation and design of steam turbines, now in common use; that you have made important contributions to the theory of the hydraulic turbine and of water hammer in conduits under pressure and have studied numerous types of centrifugal and helicoidal ventilators; that you are the inventor of the steam turbine operating under mixed pressure and of the rational utilization of exhaust steam, and that you manage with genius the works in which your turbo-compressors and other high-speed turbine machinery are being built. Moreover, that you have taken an active part in the application of turbines to warships, that important researches in ballistics are due to you and that you are the inventor of the supercharger which greatly increases the efficiency of aeroplanes.

Although the Americans admire scientific attainment, they are first of all a people who attain results, and the enumeration of your accomplishments shows that under this head you are also entitled to their admiration.

RESPONSE BY M. RATEAU

M. Rateau, in accepting the certificate of honorary membership, responded to M. de Freminville's speech of presentation, saying in part:

It is a source of great satisfaction to me to be so highly honored by The American Society of Mechanical Engineers, but in a great measure it is also a source of pride to all the engineers in France who are being honored in my person by the American society.

At this hour when we are confronted with the tremendous work of reconstruction of the devastated regions, it is certainly a great consolation to know that our friends across the Atlantic think of us, and are to be associated with us in that task. And not alone in the work of reconstruction can we work together, but there are very many questions, the solution of which it would be highly desirable to discuss in common, such as for example, as patents, industrial research, bibliographic reports, standardization of mechanical quantities, technical education, etc., etc.

The scientific organizations of the Allied countries and of the United States have recently formed an international council of scientific research, the principal object of which is the coördination of the activities in the different branches of science and its applications. Now, applied science needs as much collective effort and organization as pure science, for there is in this field great need of coordinating the work that is now being done by the various laboratories without any joint purpose, and I take this occasion to point out that a central organization instituted by the principal societies of engineers in America and in the Allied countries, would be well qualified to occupy itself with this important matter.

In the matter of education we Frenchmen could profit much by visiting the United States and learning what is being done there in this regard. Indeed, we have had accounts of recent developments in America, such as that which M. de Freminville has given us on the progress of the Taylor System, and the work of Omer Buyse, which contains an extensive exposition of the methods of teaching in the schools of the United States. But, in spite of these efforts, the American methods remain as yet unknown by the greater part of our educators and people.

There is in France now a well-directed endeavor to reform our methods of teaching, but nothing much has yet been accomplished. Our ideas, our methods, except in special cases, are the same as they were fifty years ago. However, the time of pure speculative learning is past, and in order that we may not be overcome and ruined by our rivals in industry, in commerce, and in agriculture, it is necessary for us to have energetic men of action, and not dilettantes.

All our teaching, remarkable as it is from many points of view, seems to result in destroying initiative and energy. It cultivates, it is true, the various essential faculties of man; memory, intelligence, rectitude, logic, exact reasoning, elegance of thought and expression, etc.; but are there no abuses? Is the memory not overcharged with a number of useless details which dim the fundamental truths; and then is our teaching sufficiently comprehensive? Is an attempt made to develop also, general ideas, spirit of observation, independence of spirit, intuition, and above all courage for responsibilities, and a number of other qualities useful to the men of action? Very little, indeed.

Forgive me for making a personal reference. I have been a professor of pure and applied science and, having started young in the profession, I have followed the usual errors. Now that I have seen and studied teaching methods in other countries, have visited many technical schools and other laboratories in America, England and Germany, and have given considerable thought to their methods, I can truly say that if I were to undertake teaching again, I would adopt radically different methods with the conviction that my students would derive a much greater benefit.

Why should we not send our best men, those capable of becoming professors, to foreign countries, particularly America, where they can see for themselves the results obtained by foreign methods of teaching? A few months would be sufficient and they would be admirably received there.

Instruction trips have been organized for young engineers, but it would be more profitable still to organize trips for men capable of comparing our methods with those of other peoples, and of deriving a great profit from their study. I for one am sure that it would be time and money well spent.

Reciprocally, others can learn from us what is best in our methods. These, however, are fairly well known. Our schools of the last century, particularly l'Ecole Polytechnique, that admirable creation of the great men of the Convention, have served as models to numerous institutions outside of the boundaries of France, with such modifications as have been necessitated by special local conditions, and the progress of technical science. It is now our turn to look about. To examine and to study the achievements of our contemporaries with a view to benefiting by them, can never be a sign of inferiority, but exactly the reverse.

M. Baclé, vice-president of the Société d'Encouragement, in the name of that society presented his compliments to M. Rateau as well as to M. de Freminville for their election to honorary membership in The American Society of Mechanical Engineers, a distinction as rarely accorded to strangers as that of honorary membership in the Institution of Naval Architects of England.

M. Baclé read the letter sent to the Société d'Encouragement by President Cooley and the Council of the Society. He said that the members of the former body were very much impressed with the marks of sympathy and friendship of their American confrères, to whom he presented the thanks of the Société and his hope that their bonds of friendship might be still further strengthened.

Biography of Auguste Rateau

M. Auguste Rateau was born on October 13, 1863, at Royan (Charente-Inférieure), France. His successful career in college at L'Ecole Polytechnique—where he graduated as honor man—and later at the Technical School of Mines, completed in 1888, presaged the distinguished life of service he has lived as an engineer.

M. Rateau typifies the eminently practical technician. He has excelled as much in the application of theoretical mechanics to the study of engineering phenomena as in the practical utilization of the machines he has perfected theoretically. For twenty years professor of engineering, he became celebrated by his numerous theoretical and experimental researches, particularly concerning the mechanics of fluids. It was during this time, in 1899, that he won the Fourneyron Prize, which had been offered by the French Academy of Sciences to any one suggesting any improvement in the theory of nozzles and confirming his results by experiments.

Some time later M. Rateau's renown had reached America. In 1904 the University of Wisconsin conferred upon him the degree of Doctor of Laws, "in recognition of his achievements as a mechanical engineer, as a contributor to the science of the flow of fluids, as a distinguished inventor of steam-turbine engines, and as an author of standard books in engineering."

In 1906, on the occasion of the celebration of the fiftieth anniversary of the Society of German Engineers, the Technical University of Higher Studies at Charlottenburg conferred upon M. Rateau the degree of Doctor of Engineering. A similar tribute was paid him by the Société de l'Industrie Minérale in 1908, and also recently by the University of Birmingham, England, and by the Institution of Mining Engineers of England.

M. Rateau's technical works comprise: Theoretical and experimental studies of the mechanics of fluids—air, steam, water—and of the machines operated by these fluids—fans and centrifugal pumps, hydraulic and steam turbines, nozzles, air propellers, etc.; aerodynamic studies (1909); turbo-compressors for aeroplane engines (1910); and the theory of aeroplanes (1919).

M. Rateau's practical contributions to industry are attested by the numerous patents bearing his name, which have been used to great advantage in industrial countries. These are spoken of in detail in M. de Freminville's address, which appears above.

NEWS OF THE ENGINEERING SOCIETIES

Conference on Human Relations in Industry, Annual Convention of National Electric Light Association, General Meeting of the American Iron and Steel Institute

Conference on Human Relations in Industry

There will be held this year at Silver Bay, Lake George, New York, August 27 to 29, a conference on Human Relations in Industry. Over six hundred representatives of industry are expected to attend, including some of the most prominent industrial leaders. Among the speakers who have already accepted are Allen T. Burns, Americanization Study of the Carnegie Foundation for the Advancement of Teaching; F. J. Kingsbury, president, Bridgeport Brass Company; Clarence H. Howard, President, Commonwealth Steel Company; C. J. Hicks, Assistant to the President, Standard Oil Company; R. B. Wolf, Consulting Engineer; S. J. Carpenter, Lumber Manufacturer; L. P. Alford, Editor, *Industrial Management;* and Timothy Healy, International Brotherhood of Stationary Firemen.

A similar conference held at Silver Bay last year, attended by five hundred prominent industrial leaders and others, created a demand for a larger conference this year. The greatest problems of the day are industrial. The most important factor in industry is the human factor. Men dealing with the human factor want to get together, exchange experiences, and discuss these matters with experts in the field; a conference at Silver Bay affords the ideal opportunity. Members of the Society who would like to attend should reserve accommodations through Mr. Fred H. Rindge, Jr., 347 Madison Ave., New York City.

National Electric Light Association

THE forty-third annual convention of the National Electric Light Association was held at Pasadena, Cal., on May 18-22. The deliberations forcefully indicated that the public utilities of the country are no longer facing the question of obtaining business, but rather that of obtaining funds with which to finance the extensions necessary to meet the rapidly increasing demands for electric service. Coupled with the appreciation of the seriousness of the financial situation was the realization that utilities are essential public servants and that their salvation lies in close relationship with public sentiment.

Numerous committee reports and technical papers were presented. One of the most important, complete and comprehensive reports was that of the committee on water-power development. It contained statistics of present and potential water power in the United States. The latest authentic estimate shows there is approximately 50,360,000 hp. of potential undeveloped water power in the United States, and only 9,823,540 hp. of developed water power. Of the potential maximum power, 68.6 per cent lies in California, Oregon, Washington, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming. Of the total maximum potential water power of the United States, 74.3 per cent represents undeveloped power coming under federal jurisdiction. In the western states 94 per cent of the maximum potential water power is in this class. In other words, practically all of the future development of water power in the western states, covering approximately 70 per cent of the total potential water power of the country, will be dependent upon federal action in the matter of issuance of workable permits for the development of these projects. Only 16.6 per cent of the maximum potential water power has been developed up to the present time. For the western states this proportion is only 6.5 per cent. In the case of central and eastern states, particularly the New England states, a comparatively large portion of the potential water power has been already developed.

Figures tabulated by districts showed that the per capita use of electricity in the far-western states is 2.21 times that of the remainder of the nation. Electric power rates average 1.65 cents per kw-hr. in the western section, as compared with 2.19 cents per kw-hr. elsewhere in the country.

Reference was made to projected developments in eastern states. More than 1,000,000 hp. is contemplated in Alabama, North Carolina, Georgia and Maryland. Electrification of the western trunk-line railroads will require development of a portion of the water power in that territory. Data obtained from 52 power companies of the far-western states, showing their loads during the past ten years, and also their estimated loads up to and including 1928, were obtained and compiled for presentation in the report in connection with graphic charts. They show that during the next ten years the expected development of power in the West will rise to the vast total of 1,776,260 kw. At the present prices for material and labor this improvement will involve an investment of over $700,000,000.

That increasing costs and the scarcity of labor are resulting in the more general and more rapid commercialization of electricity and electrical appliances, was stated by John G. Learned, chairman of the commercial section. Electric furnaces for steel making, he said, are now almost a necessity and many have been installed this year for melting brass. Further advances have been made in the application of electrical energy in the reduction of copper, zinc, and aluminum, and in the manufacture of nitrates and chlorine compounds. Electricity for ice making has been developed to such a degree in some places that entire communities are dependent upon central-station service for ice. Industries are employing small electrical appliances to facilitate production.

An address on The Use of Central-Station Power in Electric Furnaces was delivered by Robert M. Keeney, director of the department of metallurgical research, Colorado School of Mines. He pointed out the great possibilities for central-station service in the electric-furnace field, stating that over 200 companies in this country have furnace loads that are considered very desirable. Electric melting of steel and scrap to produce low-grade pig iron has a big future in the western states. There are 875 electric furnaces in the world, of which 363 are in service in the United States, of a total capacity of 1600 tons, with an input of 600,000 kva. The production of electric steel in this country totaled 500,000 tons last year. Electric furnaces have a poor load factor, but this is due mainly to poor operation, the tendency in design being to increase the demand input per ton. Heavy reactances are being eliminated. Speaking further of the relation of the electric furnace to central stations, Mr. Keeney said that small furnaces operating 24 hours per day should be encouraged. He also referred to the development of brass melting by electricity.

American Iron and Steel Institute

THE seventeenth general meeting of the American Iron and Steel Institute was held in New York on May 28. The opening address by Judge Gary dealt with business conditions in the industry. He referred to the panic of 1907 when the industry had successfully confronted the difficulties which arose in that critical period, and expressed his confidence that now in another period of stress the iron and steel men were ready to do their full duty again.

Joseph G. Butler, Jr., Youngstown, Ohio, spoke on the contribution of the iron and steel industries to the war, stating that a conservative estimate made from the latest information at hand placed the amount of steel contributed to the combined armies and navies of the Allied countries at not less than 100,000,000 tons.

The technical papers were of the customary high order. George Otis Smith, director, United States Geological Survey, spoke on the rapidly diminishing oil resources of the United States and on the relation between the steel and oil industries. It appears that in terms of oil the decade 1910-1920 has witnessed a transition from over-supply to over-demand. Ten years ago the wells of the United States were adding to our reserve stocks 15,000,000 bbl. in a year; in the last nine months our stored petroleum has been drawn upon to the extent of 15,000,000 bbl. The first three months of 1920 have established a rate of domestic production that if unchecked will mean a total for the year of 415,000,000 bbl., or nearly twice the output of 1910, and a rate of consumption that would make the year's requirements more than 490,000,000 bbl., or one-seventh more than last year's consumption. An estimate of the petroleum resources of the world, to which Mr. Smith referred, gives 60,000,000,000 bbl. as the total figure, with 7,000,000,000 bbl. as the quantity remaining available in the ground in the United States. Thus, if our present rate of consumption of nearly half a billion barrels per year continues unchecked, our estimated supply cannot last fifteen years longer.

Mr. Smith also discussed the possible remedies. The conversion into motor benzol of the light oils obtained as coke byproducts in steel manufacture cannot be regarded as promising enough motor fuel even to meet the present increase in demand. Steel plants now in operation and under construction have a capacity of less than 2,000,000 bbl. a year. A better hope lies in exploiting the oil-shale resources of the United States, as their oil content is fairly comparable with the petroleum reserves of the world. But as the oil thus obtained could not be as cheap that that flowing from the wells, it is not at all unlikely that the next generation of American business men will see their trade rivals across the Atlantic turning the wheels of industry and commerce with cheaper oil than will be available in the American markets. Concluding his paper, Mr. Smith urged discouragement of the use of fuel oil as a substitute for coal in stationary power plants, and pioneering by American oil companies in other countries, particularly in South America, which continent is credited with a third more oil reserves than the United States.

The report of progress in an investigation on the fatigue of metals under repeated stress, being conducted under the auspices of the National Research Council, Engineering Foundation and the Illinois Engineering Experiment Station, was presented by H. F. Moore, research professor, and J. B. Kommers, associate professor of engineering materials, University of Illinois, Urbana, Ill. It has been ascertained that the cause of failure under repeated stress is not due to crystallization of metal, as it has been thought, but to the breaking up of crystals within the metal. Metals while being subjected to fatigue were observed under the microscope, and it was found that the crystals of which the metal was composed would allow deformation to occur by movement along certain gliding planes within them. Fatigue failure would follow a path through the crystal grains themselves rather than along their boundaries, and this was true even though in going from one crystal to another the plane of failure would change its direction, because of the different orientation of the crystals. The primary cause, therefore, of fatigue failure is localized deformation. This deformation in any particular crystal is very small in amount, and apparently even very accurate and sensitive extensometers cannot detect the deterioration which is going on.

Tests conducted with apparatus of extreme sensitiveness showed that the action of materials within the ordinary elastic limit is not perfectly elastic. For instance, when a specimen is first loaded in tension, and then the load is reduced to zero, the return path of the stress-deformation curve does not coincide with the original path, but lies slightly lower, the deformation seeming to lag behind the stress, so that when the stress is zero the deformation of the specimen is not yet back to zero. If now the specimen is loaded in compression, and the load reduced to zero, it is found that a loop has been formed by the stress-deformation curve. This loop is called a mechanical hysteresis loop, from analogy with magnetic hysteresis. The area of this loop represents energy which has been absorbed by the specimen, but which has not been given back again. In each cycle of stress, therefore, there is a small amount of work done because of the inelastic action of the material. It is planned to complete a series of fatigue tests of several typical steels accompanied by very careful static tests, in order to secure data as to the relation of fatigue-resisting power to the ordinary static elastic properties.

Other technical papers were: The Microscope and the Heat Treatment of Steel, by Albert Sauveur; The Acid Open-Hearth Process, by B. E. L. De Maré; Pipeless Rolled Products from Annular Blooms, by C. A. Witter; and Welfare Work in the Steel Industry, by C. L. Close.

LIBRARY NOTES AND BOOK REVIEWS

Airman's International Dictionary. Including the most important technical terms of aircraft construction; English, French, Italian and German. Edited by Mario Mele Dander. Charles Griffin & Co., Ltd., London, 1919 (J. B. Lippincott Co., Philadelphia). Cloth, 4 x 6 in., 227 pp., 6s.

The terms in this dictionary are classified under systematic headings, so that those relating to a particular part of the airplane are brought together and an alphabetical index is provided.

Asbestos and the Asbestos Industry and Other Fireproof Materials. By A. Leonard Summers. Sir Isaac Pitman & Sons, Ltd., London, New York, n. d. Cloth, 5 x 7 in., 107 pp., illus., plates, 2s. 6d.

This little book gives a non-technical account of asbestos, its sources, varieties and uses, that is intended for users of this material and for general readers, rather than for those in search of detailed information.

Automobile Construction and Repair. With Questions and Answers. By Morris A. Hall. American Technical Society, Chicago, 1920. Flexible cloth, 6 x 8 in., 711 pp., illus., $3.50.

In this book the various parts of the automobile are described in detail, and explicit instructions for their adjustment and repair are given. The volume is intended for owners, chauffeurs and repairmen.

Cement. By Bertram Blount, assisted by William H. Woodcock and Henry J. Gillett. Longmans, Green & Co., New York, 1920. Cloth, 6 x 9 in., 284 pp., illus., plates, tables, $6.

This monograph, like its companion volumes, is intended to give a connected, balanced account of the cement industry in the light of our scientific knowledge of the principles underlying it. Processes are explained so far as they are necessary to elucidate principles, but no attempt is made to present minute technical details.

Die Helmoltzshe Wirbeltheorie Für Ingenieure. By G. Bauer. R. Oldenbourg, Münichen & Berlin, 1920. Paper, 7 x 10 in., 146 pp., illus., diagrams, 14 marks.

The hydrodynamic problems met in such fields as airplane and ship building call for an acquaintance with the theory of vortex motion, but this theory, although it has for some time taken a considerable and useful place in electrical theory, is less well known by those engaged in other fields, it is the author's opinion that the chief cause of this ignorance is the lack of any work from which the engineer can obtain an understanding of the theory of vortices with a minimum of effort, a lack that the present monograph is intended to supply. The method adopted is that of a commentary on Helmholtz's famous paper of 1858 on vortex motion. The paper is presented in full, with extensive illustrations and explanations. Helmholtz's two answers to Bertrand's papers on the motion of fluids are also included.

Dyke's Automobile and Gasoline Engine Encyclopedia. Treating on the Construction, Operation and Repairing of Automobiles and Gasoline Engines; also Trucks, Tractors, Airplanes and Motorcycles. By A. L. Dyke. Twelfth edition. A. L. Dyke, St. Louis, 1920. Cloth, 7 x 10 in., 940 pp., illus., charts, $6.

This well-known book has undergone its annual revision, and has also been enlarged by the addition of material on motor trucks, tractors, motorcycles and airplanes. With its wealth of illustrations and its clear practical information on all subjects connected with automobile operation and repair, it is well named an encyclopedia of the subject.

Forge Practice and Heat Treatment of Steel. By John Lord Bacon. Third edition, revised and enlarged by Edward R. Markham. John Wiley & Sons, Inc., New York, 1919. Cloth, 5 x 8 in., 418 pp., illus., tables, $1.75.

This is a textbook to accompany a course in forge practice, which explains the principles and provides a suitable set of exercises, but does not attempt to give minute instructions for making tools. The present edition has been enlarged by the inclusion of instruction in the heat treatment of steel.

Graphic Production Control. By C. E. Knoeppel, assisted by various members of the author's firm and staff. The Engineering Magazine Co., New York, 1920. Cloth, 6 x 9 in., 477 pp., illus., diagrams, charts, $6.

An inaccurate review of this book was published in the May issue of Mechanical Engineering. The book is not intended, as was stated, "to provide a complete description of the proper methods of making graphic charts and of applying them to industrial problems." It reveals a system for the control of production using graphics, charts, diagrams, dispatch boards, control boards and other forms of mechanism to visualize the facts by which control is secured.

Handbook of Natural Gas. By Henry P. Westcott. Third edition. The Metric Metal Works, Erie, Pa., 1920. Cloth, 5 x 8 in., 725 pp., illus., plates, charts, tables, $3.75.

The intention of this work is to supply a one-volume manual covering the entire industry in a practical way. It begins with a brief statement of the geology of the gas fields, followed by a history of the industry, and then proceeds successively to the properties of gases, field work, measurement of gas wells, pipeline construction and capacity-gas compression, measurement, regulation, distribution and consumption. Casinghead gasoline, the carbon black industry, helium and acetylene welding are also discussed. The present edition has been revised and enlarged.

Hardening, Tempering, Annealing and Forging of Steel, including Heat Treatment of Modern Alloy Steels. A Complete Treatise on the Practical Treatment and Working of High and Low-Grade Steel, Comprising the Selection and Identification of High and Low-Carbon Steel, and Modern Chrome-Nickel and Chrome-Vanadium Alloys; the most Modern Hardening, Tempering, Annealing and Forging Processes, the Use of Gas Blast and Electric Furnaces, and Heating Machines. By Joseph V. Woodworth. Fifth edition. The Norman W. Henley Publishing Co., New York, 1919. Cloth, 6 x 9 in., 321 pp., illus., tables, $3.

The author has prepared a compendium of practical information on the subjects mentioned, based on trade literature and personal experience, for the use of mechanics and other users of steel. The present edition has been revised and enlarged, and a section treating of the newer alloy steels has been added.

Internal-Combustion Engines. Their Principles and Application to Automobile, Aircraft and Marine Purposes. By Wallace L. Lind. Ginn & Co., Boston, (Copyright 1920). Cloth, 6 x 8 in., 225 pp., illus., chart, $2.20.

This is a brief, practical, up-to-date text for students, covering the theory and operation of these engines, but omitting the question of design.

International Commerce and Reconstruction. By Elisha M. Friedman. With a foreword by Joseph French Johnson. E. P. Dutton & Co., New York, copyright, 1920. 432 pp., 5 x 8 in., tables, $5.

Beneath the military campaigns of the war, a silent economic process has been changing the character of the commerce of the world. Profound changes have taken place, which this book attempts to trace in detail, and the principles of which it aims to discuss. It recites some of the facts essential to the formation of a new commercial and financial view and advocates a definite trade policy for the retention of our commercial gains from the war years.

Inventions. Their Development, Purchase and Sale. By William E. Baff. D. Van Nostrand Co., New York, 1920. Cloth, 8 x 5 in., 230 pp., $2.00.

The author of this work discusses the marketing of inventions. The subject is considered from the various points of view of the inventor, the capitalist or investor, and the manufacturer, and advice given to each as to the methods for making a correct judgment of the value of any invention.

A Kinetic Theory of Gases and Liquids. By Richard D. Kleeman. First edition. John Wiley & Sons, Inc., New York, 1920. Cloth, 5 x 8 in., 272 pp., tables, $3.

The object of this book is to formulate a kinetic theory of certain properties of matter, which shall apply equally well to matter in any state. By considering atoms or molecules as mere centers of forces of attraction and repulsion, instead of as elastic spheres and by modifying the definition of the free path of a molecule so that the exact nature of molecular interaction is not involved, it is possible to lay the foundation of a general kinetic theory which applies to matter in any state, and which furnishes a number of important formulas.

Pieux et Sonnettes. By Edward Noë and Louis Troch. Gauthier-Villars et Cie, Paris, 1920. Paper, 7 x 10 in., 348 pp., illus., 20 francs plus 50% temporary increase.

This work is a theoretical and practical discussion of piles and pile-driving, intended for engineers and architects. The first chapter treats of wooden piles, the second of metallic piles and the third of the different varieties of concrete piles, their advantages and disadvantages. Chapter four discusses metal-sheet piling. The theory of pile-driving is then studied, followed by a description of the various types of pile-drivers and of the method of driving by means of a water jet. The volume ends with a study of the equilibrium of piles and notes on the proper choice of piles.

Résistance des Matériaux et Elasticité. Cours Professé a l'Ecole des Ponts et Chaussées. By Gaston Pigeaud. Gauthier-Villars et Cie, Paris, 1920. Paper, 8 x 6 in., 772 pp., illus., 64 francs.

This textbook represents the instruction given at L'Ecole des Ponts et Chaussées, and its arrangement, the author states, has been largely determined by the necessity of quickly preparing the students to apply the subject in the field of girders. At the beginning there is, therefore, no attempt to introduce the study by a preliminary exposition of the theory of elasticity, and throughout there is an avoidance of abstract principles. After a brief review of the principles of mechanics and graphic statics, the theory of girders is explained. This is followed by a discussion of the various uses of the girder. The theory of elasticity is then introduced and occupies the concluding third of the book.

The Running and Maintenance of the Marine Diesel Engine. By John Lamb. Charles Griffin & Co., Ltd., London; J. B. Lippincott Co., Philadelphia, 1920. Cloth, 4 x 7 in., 231 pp., illus., plates, 8s, 6d.

This is a practical manual, intended to prepare marine engineers with no previous experience with oil engines, to qualify for positions on motorships. For this purpose the author describes the usual types of marine Diesel engines, the defects which have developed during operation and the methods that he has used to remedy them.

Technical Writing. By T. A. Rickard. First edition. John Wiley & Sons, Inc., New York. Cloth, 5 x 8 in., 178 pp., $1.50.

Mr. Rickard's primary object is to awaken the interest of engineers in the importance of the proper use of language. His volume is a discussion of the subject, in which particular attention is given to the usual faults of technical writing as he has observed them during his long experience as an editor. His rules are simple and definite, and their use is illustrated by numerous examples, so that the book will prove a useful guide to authors.

A Textbook of Inorganic Chemistry. Edited by J. Newton Friend. Vol. IX, Part I. Cobalt, Nickel, and the Elements of the Platinum Group. By J. Newton Friend. Charles Griffin & Co., Ltd., London; J. B. Lippincott Co., Philadelphia, 1920. Cloth, 6 x 9 in., 367 pp., tables, 18s.

This installment of this important reference work covers the eighth group of the Periodic Table, with the exception of iron. Like the previous volumes, it gives a concise yet full account of our present knowledge of these elements and their inorganic compounds, accompanied by numerous references to the leading works and monographs that treat of them.

Thomas' Register of American Manufacturers and First Hands in All Lines. Eleventh edition. Thomas Publishing Co., New York, 1920. Cloth, 9 x 12 in., $15.

Contents: Finding list and index; lists of manufacturers classified according to business; manufacturers of the U. S. arranged alphabetically; leading trade names, brands, etc.; banks, boards of trade and other commercial organizations; leading trade papers; manufacturers' representatives; export and import houses; steamship lines and forwarding agents; overseas importers, merchants, etc.

The eleventh edition of this widely known directory has been revised and enlarged to the size of 4500 pages. It covers manufacturers and dealers in all classes of materials, and contains a classified list of manufacturers, with indications of their approximate ratings; an alphabetical list of the more important firm names, and a list of brand or trade names of manufactured articles.

Traité de Mecanique Rationnelle. By Paul Appell. Fourth edition, vol. 1. Statique—Dynamique du Point. Gauthier-Villars et Cie, Paris, 1919. Paper, 7 x 10 in., 619 pp.

The treatise of which this book forms the first volume is a comprehensive one, covering the course given for many years in the Faculté des Sciences of Paris. The first volume includes the theory of vectors, statics, and the dynamics of particles. The present edition has been thoroughly revised and references to recent writings on the subject have been added. No previous knowledge of mechanics is assumed. The work is designed to give a thorough understanding of present knowledge of mechanics to those studying the subject in preparation for an engineering career.

Time Studies for Rate Setting. By Dwight V. Merrick, with a foreword by Carl G. Barth. The Engineering Magazine Co., New York, 1919. Leather, 6 x 9 in., 366 pp., 137 fig., $6.

The author of this work presents in amplified form the principles covering time study for rate setting, describes various mechanisms that have been found helpful in making and using such studies and presents some details of practice. An example of the application of time studies to a line of machine tools is included, together with detailed times for a number of other kinds of work.

Transient Electric Phenomena and Oscillations, Theory and Calculation of. By Charles Proteus Steinmetz. Third edition, revised and enlarged. McGraw-Hill Book Co., Inc., 1920. Cloth, 6 x 9 in., 696 pp., $6.

This volume, which is to some extent a continuation of the author's Theory and Calculation of Alternating Current Phenomena, deals with the transient phenomena of the readjustment of stored electrical energy which is necessitated by a change in circuit conditions. The present edition has undergone extensive revision and expansion and has practically been rewritten. A new section, entitled Variation of Circuit Constants, has been added. The method of symbolic representation has been changed from the time diagram to the crank diagram.

Zinc and Its Alloys. By T. E. Lones. Sir Isaac Pitman & Sons, Ltd., London and New York. Cloth, 5 x 7 in., 127 pp., illus., plates, 2s, 6d.

This is a concise, readable account of the occurrence, recovery and uses of zinc, intended for persons engaged in the zinc trade or in search of general information about the metal.

DISCUSSION OF CASTING SESSIONS

(Continued from page 440)

symposium on castings, I do not find any references to sprue returns, casting losses, or melting losses. These considerations are of especial importance in the selection of an alloy for the production of castings, and in fact they might properly be regarded as governing factors in a sense.

Mr. Bierbaum does not give any data on casting losses in brass and bronze, and I wish to inquire whether he has any figures. In the founding of light aluminum-alloy castings, about 10 to 12 per cent may be taken as an average figure, on the basis of an investigation recently made by the Bureau of Mines. Average figures probably do not mean much, since casting losses necessarily vary a great deal, depending upon the type of castings made, upon local foundry conditions, and upon other determining factors. However, it would be useful for comparative purposes to know what the average casting losses in brass and bronze are. I do not here refer to melting losses, but have specific reference to actual scrap (casting) losses incurred because of rejections of castings in which foundry defects exist.

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

Published Monthly by The American Society of Mechanical Engineers

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THE following pages form a descriptive Index to articles on engineering and related subjects which have appeared in current technical periodicals. In its preparation the Society's engineering staff regularly reviews all of the technical journals and society publications received by the Engineering Societies Library. These form one of the greatest and most complete collections of scientific periodicals in the world and comprise upward of 1100 distinct publications in some ten languages. The Index is alphabetically arranged with numerous cross-references, the items being placed under appropriate subject headings. The main abbreviations used in the items are given at the bottom of this page.

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ABRASIVE WHEELS

Manufacture and Uses

Grinding Wheels; Their Manufacture, Uses in Industry, and Factors Affecting Their Selection, Wallace T. Montague. Proc. Engrs. Soc. Western Pa., vol. 36, no. 3, April, 1920, pp. 205-216 and (discussion) pp. 217-220. With table giving recommended speeds for different classes of grinding.

ACCIDENT PREVENTION

Railroad Work

Safety in Railway Working, J. Tréviéres. Bul. Int. Ry. Assn., vol. 2, no. 4, April, 1920, pp. 204-212. French Ministerial Circular of Nov., 1919, orders that all absolute stop signals, danger semaphores, as well as distant-signal disks and signals at junctions and other dangerous places, be supplemented by detonators, unless such signals are fitted with electrical or mechanical repeating appliances; also that on lines fitted with block system, trains stopped within 1,100 yd of their protecting semaphore, be protected by hand-placed detonators laid 1,100 yd. in rear of such trains. Translated from Genie Civil.

ACCIDENTS

Mines

How Age and Occupation Affect Frequency and Duration of Disabilities, W. W. Adams. Coal Age, vol. 17, no. 25, June 17, 1920, pp. 1256-1258, 1 fig. Chart showing number of disability cases and of disability days for age periods, computed from figures of insurance company.

AEROPLANE ENGINES

Carburetors

See CARBURETORS.

Fuel Consumption

The Fuel and Oil Consumption of Automobile and Aeroplane Engines (Die Brennstoff- und Oelverbrauchsmessung von Fahrzeug- und Flugmotoren), K. Fr. Nägele. Motorwagen, vol. 22, no. 36, Dec. 31, 1919, pp. 687-693, 22 figs. Description of the Seppeler apparatus.

High-Altitude

A New Engine-Testing Plant, R. S. McBride. Am. Mach., vol. 52, no. 20, May 13, 1920, pp. 1061-1063. Description of plant of Bur. of Standards, with special reference to apparatus used when testing airplane engines for simulating conditions encountered at high altitudes.

Construction of High-Output Aeroplane Engines for High Altitudes (Konstruktionserwägungen über Höhen-Volleistungsmotoren), F. Ernst Bielefeld. Motorwagen, vol. 23, no. 2, Jan. 20, 1920, pp. 33-37, 18 figs. Details and illustrations of various types of 2-stroke and 4-stroke engines and devices for testing engines under variable atmospheric pressure, etc. Curves are given which show output and fuel consumption of high-output engines at high altitudes.

Flight at High Altitudes (Sur les vols aux hautes altitudes), Jean Villey. Comptes rendus des séances de l'Academie des Sciences, vol. 170, no. 16, April 19, 1920, pp. 924-927. Notes on oversized aeroplane engines.

Liberty

Liberty Motor Connecting-Rods, H. A. Carhart. Am Mach., vol. 52, no. 22, May 27, 1920, pp. 1148-1152, 24 figs. Jigs and fixtures used.

Machining the Liberty Crankcase—I, H. A. Carhart. Am. Mach., vol. 52, no. 24, June 10, 1920, pp. 1247-1252, 15 figs. Jigs and fixtures used with data as to cost of hand labor.

The Increase of Power Output with Higher Compression Ratios. Automotive Industries, vol. 42, no. 21, May 20, 1920, pp. 1158-1159, 4 figs. Results of tests at McCook Field. Three sets of pistons were utilized in standard Liberty engine and characteristics were determined of high, medium and low compression ratio. Fuel consumption decreased as compression ratio was enlarged.

Radiators

Design Factors for Airplane Radiators, Samuel R. Parsons. Jl. Soc. Automotive Engrs., vol. 6, no. 6, June, 1920, pp. 437-442. Based on formulæ and data published in reports of National Advisory Committee for Aeronautics.

Effect of Altitude on Radiator Performance, W. S. James and S. R. Parsons. Nat. Advisory Committee for Aeronautics, report no. 62, 1920, 13 pp., 10 figs. Method for estimating performance on radiator under altitude conditions in terms of its performance on ground is developed from data on effect of temperature and density of air on dissipation of heat and absorption of power.

Radiators and Cooling Systems for Aircraft Engines, R. N. Liptrot. Aeronautics, vol. 18, no. 342, May 6, 1920, pp. 364-366, 1 fig. Notes on design of water-tube and honeycomb radiators. Reference is made to experiences which are said to have demonstrated that yawing honeycomb radiator at angle with direction of flight increases its cooling effect. Lecture delivered before Inst. of Aeronautical Engrs.

The Investigation of Aircraft Radiators at the Bureau of Standards, Samuel R. Parsons. Aerial Age, vol. 11, no. 14, June 14, 1920, pp. 476-478, 4 figs. Summary of experimental results obtained at laboratory of Bureau of Standards.

Rotary

Constructive Details of Rotary Aeroplane Engines (Konstruktive Einzelbeiten an Umlaufmotoren), H. Praetorius. Motorwagen, vol. 23, no. 2, Jan. 20, 1920, pp. 21-24, 6 figs. Writer points out importance of development of connecting rods and gives descriptions and illustrations of various types of construction.

Shape as Affecting Aeroplane Operation

Engine Shape as Affecting Airplane Operation, Grover C. Loening. Jl. Soc. Automotive Engrs., vol. 6, no. 6, June, 1920, pp. 417-421, 7 figs. Graphs are constructed with data published in technical press. Abscissæ are speeds in miles per hour, and ordinates total air resistance of engine due to its shape and its weight as carried by wing.

Tests

A Study of Airplane Engine Tests, Victor R. Gage. Nat. Advisory Committee for Aeronautics, no. 46, 1920, 39 pp. 33 figs. Results obtained from tests on Hispano-Suiza aeroplane engine in altitude laboratory of Bur. of Standards. Among results found are: Indicated horsepower decreases in direct proportion to decreased density of air; brake thermal efficiency remains constant at about 24 per cent on ground at all speeds; heat lost in exhaust is at maximum at 1900 r.p.m. at all altitudes, and amounts to almost 50 per cent of heat supplied on ground, decreasing to about 40 per cent at 30,000 ft. altitude; heat lost through friction varies from 2 per cent at 1700 r.p.m. and 3 per cent at 2100 r.p.m. on ground to 6 and 8 per cent, respectively, at 30,000 ft. altitude; and heat loss in jacket water is about 17 per cent of that supplied at all speeds on ground, increasing to 28 per cent

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Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ENGINEERING INDEX (Continued)

at 2100 r.p.m. and 35 per cent at 1300 r.p.m. at 30,000 ft.

Tests on Liberty, Benz and Mercedes Engine Manifolds. Automotive Industries, vol. 42, no. 22, May 27, 1920, pp. 1204-1207, 12 figs. Difference in fuel consumption found in using various engine manifolds, power output remaining practically the same in each case. Tests conducted at McCook Field.

See also High-Altitude; Liberty.

AEROPLANE PROPELLERS

Bakelite Micarta

Bakelite Micarta Propellers. Aviation, vol. 8, no. 9, June 1, 1920, pp. 354-357, 4 figs. Method of manufacture and graph of flight tests of wooden and micarta propellers.

Tests

Experimental Research on Air Propellers, III, W. F. Durand and E. P. Lesley. Nat. Advisory Committee for Aeronautics, no. 64, 1920, 35 pp. 44 figs. Influence of following characteristics was examined: (1) nominal pitch ratio 1.3 combined with certain number of more common forms and proportions; (2) driving face slightly rounded or convex; (3) change in location of maximum thickness ordinate of blade section; and (4) pushing forward leading edge of blade, thus giving rounded convex surface on leading side of driving face.

[See also WIND TUNNELS.]

AEROPLANES

Aerofoils for Internal Bracing

The Aerodynamic Properties of Thick Aerofoils Suitable for Internal Bracing, F. H. Norton. Flight, vol. 12, no. 19, May 6, 1920, pp. 499-501, 3 figs. Graphs showing mean thickness of wing against *Lc, Dc* and *L-D* for various angles of incidence and against *L-D* for various values of *Lc*. (Concluded.)

Amphibian Planes

Navy Specifications for Two-Place Amphibian Planes. Aviation, vol. 8, no 9, June 1, 1920, p. 362. Specifications issued by Bureaus of Construction and Repair and of Steam Engineering, Navy Department, for aeroplanes capable of being used either as seaplanes or as land planes.

Design

The Aeroplane of Consistent Strength, A. J. Sutton Pippard. Eng, vol. 109, no. 2822, Jan. 30, 1920, pp. 133-134. Method of design is suggested in which strength is specified in terms of load factor of wings with center of pressure in its most forward position.

Fiat

Fiat Twelve-Passenger Aeroplane. Aeronautics, vol. 18, no. 343, May 13, 1920, p. 377, 3 figs. Characteristics: Weight loaded, 11,000 lb.; power of engine, maximum, 900 hp. at 1850 r.p.m.; minimum, 700 hp. at 1600 r.p.m.

Free-Flight Tests

Preliminary Report on Free Flight Tests, E. P. Warner and F. H. Norton. Nat. Advisory Committee for Aeronautics, no. 70, 1920, 33 pp. 33 figs. Tests were made on two training machines of JN4H type, both of which were equipped with Hispano-Suiza 150-hp. engines.

Load Factors

Load Factors for Aeroplanes and Seaplanes. Eng., vol. 109, no. 2833, Apr. 16, 1920, p. 511. Report of sub-committee appointed by Advisory Committee for Aeronautics to consider and report "as to the definite rules which should be adopted to govern the load factors required for all classes of civil aircraft, and upon which certificates of airworthiness may be based."

Metal Construction

The Development of Metal Construction in Aircraft, J. S. Nicholson. Eng., vol. 109, nos. 2828, 2829 and 2830, Mar. 12, 19 and 26, 1920, pp. 357-362, 23 figs. 375-378, 9 figs., and 408-412, 15 figs. Notes on structural design of main planes and on developments which have recently taken place in construction of all-metal aeroplane. Brief résumé of scientific principles underlying design of struts and beams, and of struts with lateral loading, is included. Paper read before Instn. of Engrs. & Shipbuilders in Scotland.

Navy Torpedo Planes

New Glenn L. Martin Navy Torpedo Plane. Aviation, vol. 8, no. 9, June 1, 1920, pp. 359-360, 5 figs. Characteristics: Wing span, overall, 71 ft. 5 in.; length, overall, 46 ft. 4 in.; height, overall, 14 ft.; weight, gross, 11,487 lbs.; economical speed at sea level, 95 m.p.h.; service ceiling, 10,000 ft.; absolute ceiling, 12,000 ft.; motors, two 12-cyl. Liberty motors, each 400 hp., rated at 1700 r.p.m. with self-starters.

Spars, Vibration of

The Vibration of Spars in Aircraft, A. H. Stuart. Eng., vol. 109, no. 2824, Feb. 13, 1920, p. 201, 9 figs. Results of experiments conducted to determine cause of vibrations in lower plane of aeroplane at high engine speed.

Stresses

The Loads and Stresses on Aeroplanes, John Case. Aeronautics, vol. 18, nos. 342, 343, 345, 346, May 6, 13, 27 and June 3, 1920, pp.-363, 3 figs., pp. 382-383, 4 figs., pp. 414-415, 2 figs., pp. 428-429, 4 figs. Stresses in ailerons. Torque diagram for aileron spar, and example of aileron calculation. Formulæ for torsional stresses in spars. Formulæ for computing torsion of spars of elliptic section and of rectangular section, as well as of irregular shape. (Continuation of serial.)

Wing Beams

The Strength of One-Piece Solid, Built-Up, and Laminated Wood Airplane Wing Beams, John H. Nelson. Nat. Advisory Committee for Aeronautics, no. 35, 1919, 12 pp. 12 figs. It was found in tests that beams of fir can be produced which, weight for weight, will prove as strong as those made of spruce, but will not, however, show quite same stiffness. Cypress was not found satisfactory substitute for spruce. Beams of laminated construction showed themselves as strong as one-piece solid construction.

Wing-Fabric Fastenings

Fabric Fastenings, E. D. Whalen and R. T. Fisher. Aerial Age, vol. 11, no. 14, June 14, 1920, pp. 474-475. It is concluded from tests that (1) unwaxed cotton cords are materially better resistors of abrasion fray than unwaxed linen, (2) waxen linen and cotton have practically the same resistance to abrasion fray, and (3) waxed or unwaxed cotton cords are materially better than waxed or unwaxed linen as a resistor of tension fray.

[See also FLYING BOATS; PARACHUTES; WIND TUNNELS.]

AIR FILTERS

Non-Fabric

Construction of Air Filters without Cotton or Other Fabrics (Stofflose Luftfilter), Ernst Preger. Werkstattstechnik, vol. 14, no. 3, Feb. 1, 1920, pp. 71-73, 16 figs. Types operating according to principle of subjecting the air to a repeated change of direction and thereby causing the dust to settle on walls to which it adheres.

AIR FLOW

Small Tubes

The Flow of Air Through Small Brass Tubes, T. S. Taylor. Mech. Eng., vol. 42, no. 6, June 1920, pp. 334-335, 2 figs. Flow of air through brass tubes ⅝ in., ⅞ in. and 1½ in. in diameter was studied by means of small pitot tubes. It was observed that velocity distribution did not become constant in tubes of these dimensions until air had passed through length of about 200 cm. Ratio of average velocity to maximum velocity at center was found to have value of from 0.82 to 0.85 for all velocities for each of tubes tested.

AIRCRAFT CONSTRUCTION MATERIALS

See STEEL, HEAT TREATMENT OF, Brazed Fittings for Aircraft.

AIRSHIPS

R.33 and R.34

The Machinery of H. M. Airships R.33 and R.34. Eng., vol. 109, nos. 2831 and 2833, Apr. 2 and 16, 1920, pp. 433-434, 7 figs., and 504-505, 10 figs. partly on supp. plate. Structural details of gondolas. Details of Sunbeam-Coatalen "Maori" engines with which both vessels are fitted.

Rigid

Rigid Airships and Their Development, J. E. M. Pritchard. Flight, vol. 12, nos. 20, 21, 22 and 23, May 13, 20, 27 and June 3, 1920, pp. 525-528, 4 figs., pp. 554-557, 7 figs., pp. 578-581, 4 figs., pp. 597-600, 8 figs. Accepted functions of both military and commercial rigid airships are outlined and divergence between two types indicated. Structural features of hull, fabric and cars are discussed. Keel, fins and planes. Outer cover requirements to prevent superheating. Comparative study of Zeppelin type and British type of car suspensions. Paper read before Roy. Aeronautical Soc.

The Effect of Size upon Performance of Rigid Airships, C. I. R. Campbell and H. May. Eng., vol. 109. no. 2831, Apr. 2, 1920, pp. 464-466, 4 figs. Weights of various parts are expressed as function of total lift and formula is developed applicable to all ships of any given type, expressing total fixed weight as proportion of total lift. Curves of performance are given for airships similar in type to R.38 over large range of total lift. Paper read before Instn. Naval Architects.

Semi-Rigid

The Italian Semi-Rigid Airship Roma. Aerial Age, vol. 11, no. 14, June 14, 1920, p. 478, 2 figs. Characteristics: Volume, 1,200,000 cu. ft.; total weight, 34 gross tons; length, 125 m.; beam, 25 m.; height, 27.5 m.

[See also HANGARS.]

ALLOYS

Electrical Melting

Electrical Melting of Alloys— I, II, III, IV, V, VI, VII and VIII, H. W. Gillett. Foundry, vol. 48, nos. 4, 5, 6, 7, 8, 9, 10, 11 and 12, March 1 and 15, April 1 and 15, May 1 and 15, June 1 and 15, 1920, pp. 177-180, 229-231 and p. 238, 275-281, 319-323, 362-366, 400-406, 445-453 and p. 457, 486-491, 67 figs. Fundamental reasons underlying evolution of electric furnaces for melting non-ferrous metals are analyzed, essential and desirable features of these furnaces are outlined and distinctions are drawn between their relative merits. It is stated that direct arc furnaces which have won their position in steel making fields have been successfully adapted to non-ferrous melting where volatile alloys are absent, and that indirect arc types have proven successful upon non-ferrous alloys containing under 20 per cent of volatile metals. For zinc-bearing alloys, it is added, indirect arc type has been used successfully by agitating both to prevent local heating. Success of resistance furnaces is believed to depend upon refractories for roof and resistor container, which withstand high heat. Induction type furnaces, it is said, offer advantages in melting certain alloys, but possess limitations which prevent their use for high-lead or copper alloys.

Ternary, Model for

A Model for Representing the Constitution of Ternary Alloys, Walter Rosenhain. Eng., vol. 109, no. 2833, Apr. 16, 1920, pp. 527-529, 4 figs. Model constructed of wires of various thicknesses and colors at National Physical Laboratory, England.

ALTERNATORS

See ELECTRIC GENERATORS, A. C.

ALUMINUM

Automobile Uses

The Use of Aluminum in the Present and the Future Motor Car, Ferdinand Jehle. Jl. Soc. Automotive Engrs., vol. 6, no. 6, June, 1920, pp. 367-372, 6 figs. Use of aluminum alloys in pistons, crankcases, cylinder blocks, oil pans, inlet manifolds, bodies, etc. is noted, and it is visualized that wheels, rear-axle housings and similar parts will be aluminized in near future.

Corrosion

Rate of Corrosion of Aluminium, G. H. Bailey. Jl. Soc. Chem. Indus., vol. 39, no. 9, May 15, 1920, pp. 118T-120T, 2 figs. Bailey's empirical formula is said to be confirmed by results obtained in series of experiments extending over ten years. Extent of corrosion in terms of metal corroded per day per 100 sq. cm. of surface is expressed by $CR = 9/8\,(S + w - W)$ where W is weight of sheet employed, w its weight after exposure, and S weight of precipitate obtained from corrosive liquid after ignition. (See Jl. Inst. Metals, 1912, vol. 9, p. 79.)

The Action on Aluminum of Hard Industrial Waters, Richard Seligman and Percy Williams. Eng., vol. 109, no. 2828, Mar. 12, 1920, pp. 362-364. Experiments performed by writers are said to have established that oxidation is first stage in corrosion of aluminum by water and is prime cause of both etching and pitting. Comparative tests were made of chemical and electrochemical methods for protecting aluminum from hard industrial waters. Paper read before Inst. of Metals.

ALUMINUM ALLOYS

Duralumin

Increasing Use of Alloyed Aluminum as an Engineering Material—II, G. M. Rollason. Indus. Management, vol. 59, no. 6, June, 1920, pp. 456-461, 10 figs. Composition and physical properties of more important aluminum alloys, particularly duralumin.

Impact Tests

Charpy Impact Test as Applied to Aluminum Alloys, E. H. Dix. Min. & Metallurgy, no. 160, April, 1920, p. 31. It is concluded from results of tests at Lynite Laboratories of Aluminum Manufactures, Inc., that Charpy impact resistance of copper-aluminum alloys decreases with increase of copper content.

AMMONIA COMPRESSORS

Direct-Connected

Direct Connected Compressors, C. N. Drake. Ice & Refrigeration, vol. 58, no. 5, May, 1920, pp. 267-268. Advantages quoted for direct-connected synchronous motor drive for am-

Let's Use the Right Name

The name "Screw Machine" is no longer appropriate when applied to the modern Turret Lathe. It is seldom used for making screws—(automatics serve the purpose better for large quantities). Its field of work is as universal now as that of the engine lathe. Where bar work was almost the only product ten years ago, chucking work is now in the majority. Then, too, the modern Turret Lathe has in its design and construction, characteristics and power to handle tough forgings and alloy steel parts that would be superfluous for making screws.

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(Bar Capacity—3½″ x 44″ or 4½″ x 44″—16″ Chuck Capacity)

No. 4—Universal Turret Lathe
(Capacity—1½″ x 10″—16″ Swing)

Nos. 1 (5/8″ x 4″)—2 (1″ x 6″)—4 (1½″ x 8″) Plain Turret Lathes

Nos. 2 (1″ x 6″)—4 (1½″ x 8″)—6 (2¼″ x 12″) Geared Friction Head Turret Lathes

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Salt Lake Hardware Company, Salt Lake City, Utah.
Smith-Booth-Usher Company, Los Angeles, Calif.
Fred Ward & Son, San Francisco, Calif.
Portland Machinery Company, Portland, Oregon.
Hallidie Machinery Company, Seattle, Wash.
Hendrie & Bolthoff Mfg. & Supply Company, Denver, Col.
Peden Iron & Steel Company, Houston, Texas.

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Williams & Wilson, Ltd., Montreal.

ENGINEERING INDEX (Continued)

monia compressors are: (1) higher motor efficiency, (2) elimination of belts and transmission losses, (3) high power factor with consequent lower power rates, and (4) saving in floor space.

ARCHES

Reinforced-Concrete

Novel Concrete Arches for Garage Roof Supports, G. E. Warren. Concrete, vol. 16, no. 5, May, 1920, pp. 210-212, 7 figs. Span width of each of arches is 103 ft. 7½ in. over all.

AUDIONS

See RADIOTELEGRAPHY Audion Connections.

AUTOGENOUS WELDING

French System

A New Method of Welding. Sci. Am. Monthly, vol. 1, no. 6, June, 1920, p. 522, 3 figs. French system of holding welding rod to rear of torch. Translated from Revue de la Soudure Autogène.

AUTOMOBILE ENGINES

Air Cooling of

The Air Cooling of Petrol Engines, A. H. Gibson. Eng., vol. 109, no. 2824, Feb. 13, 1920, pp. 211-213. Records obtained in experiments with aeroplane engines. Results are, however, presented as useful to design of air-cooled gasoline engine for car work. (To be continued.) Paper read before Instn. Automobile Engrs.

Carburetors

See CARBURETORS.

Connecting Rods

Comparative Methods of Machining Automobile Engine Connecting Rods, Fred H. Colvin. Am. Mach., vol. 52, no. 20, May 13, 1920, pp. 1023-1035, 42 figs. Practices in manufacture of connecting rods for Packard, Cadillac, Peerless, Chandler and Franklin cars.

Producing 17,000 Connecting Rods a Day—I, Fred H. Colvin. Am. Mach., vol. 52, no. 23, June 3, 1920, pp. 1199-1203, 13 figs. Methods used by Ford Motor Co. Rod and cap are forged separately up to final boring, facing and broaching operation.

Crankshafts

Inertia Torque in Crankshafts, F. A. Stepney Acres. Automobile Engr., vol. 10, no. 138, May, 1920, pp. 208-216, 16 figs. Different crank arrangements are compared from viewpoint of internal stresses in crankshaft set up by inertia torque.

Die-Cast Bearings

The Manufacture and Use of Die-Cast Engine Bearings, H. C. Skinner. Automotive Industries, vol. 42, no. 21, May 20, 1920, pp. 1160-1162, 7 figs. Experience and present practice of Franklin Die-Casting Corp.

Dorman

Dorman Internal-Combustion Engines. Eng., vol. 109, no. 2828, Mar. 12, 1920, pp. 342-344, 9 figs. partly on supp. plate. Details of two models, 25-hp. commercial vehicle type and 12-hp. overhead-valve car engine.

AUTOMOBILE FUELS

Natalite

Fuel for Internal-Combustion Engine. Eng., vol. 109, no. 2822, Jan. 30, 1920, p. 150. Properties of "Natalite," a fuel manufactured at Natal, South Africa, composed of 54 per cent ethyl alcohol, 45 per cent ether, and 1 per cent trimethylamine.

Spontaneous Ignition Temperatures

Spontaneous-Ignition Temperatures of Liquid Fuels, Harold Moore. Automobile Engr., vol. 10, no. 138, May 1920, pp. 199-204, 14 figs. Results of experimental measurements of temperatures of spontaneous ignition for kerosene-creosote mixtures, petrol-xylol mixtures, ether-xylol, ether-kerosene mixtures, petrol-benzole mixtures, and cannel oil-creosote mixtures.

[See GASOLINE.]

AUTOMOBILES

Angus-Sanderson

Transmission and Control for Angus-Sanderson Motor Car. Eng., vol. 109, no. 2824, Feb. 13, 1920, pp. 210-211, 17 figs. Gear gives three forward speeds and one reverse. Gearbox, transmission, back axle and brakes form a single unit and can be assembled without reference to chassis frame.

Gear Box

A New Gear Box. Automobile Engr., vol. 10, no. 138, May 1920, pp. 205-206, 6 figs. Gear box giving four speeds forward and reverse introduced by Campbell Transmission Co., Buchanan, Mich.

Lighting and Equipment

Lighting and Equipment Laws of Various States. Automotive Industries, vol. 42, no. 21, May 20, 1920, pp. 1164-1165. Tables showing general features of State laws relating to headlights, dimmers, spotlight, turn or stop signals and mirrors for motor vehicles.

Production Increase

Production Expansion Obtained in the Assembly Track Layout, J. Edward Schipper. Automotive Industries, vol. 42, no. 22, May 27, 1920, pp. 1210-1213, 6 figs. It is said that Hudson Co. has increased its production facilities from 160 to 250 cars daily by rearranging assembly track layout.

Rear Axles, Manufacture of

Manufacturing Clark Rear Axles—II, Edward K. Hammond. Machy. (N. Y.), vol. 26, no. 9, May 1920, pp. 801-806, 14 figs. Description of methods used by Clark Equipment Co., Buchanan, Mich., in manufacture of automobile rear axles, including machining operations on dead and live axles, axle housings, brake supports, brake drums and gear cases.

Tires, Molds for

Machining Molds and Cores for Auto Tires, W. O. Francis. Am Mach., vol. 52, no. 21, May 20, 1920, pp. 1099-1102, 17 figs. Methods used by some of the large tire manufacturers.

Uses in War

Automotive Vehicles in the Great War, Clarence J. West. Jl. Soc. Automotive Engrs., vol. 6, no. 6, June 1920, pp. 409-416. Bibliography of important articles in technical journals of United States and other countries relating to use of automobiles and motor trucks.

[See also ALUMINUM, Automobile Uses; STEEL MANUFACTURE, Automobile Steels.]

AUTOMOTIVE INDUSTRY

Developments

Current Development of Automotive Industries. Jl. Soc. Automotive Engrs., vol. 6, no. 6, June 1920, pp. 381-386. It is estimated that there is at present potential demand for 2,000,000 cars. Attention is directed to development of detachable-head engines, heating devices for intake manifolds, increased use of semi-floating rear axles and tendency toward pneumatic equipment for trucks having capacities above 2 tons.

AVIATION

Commercial

Aerial Transport from a Business Point of View, Sir Sefton Brancker. Aeronautical Jl., vol. 24, no. 114. June, 1920, pp. 294-306 and (discussion) 306-312. Also Flight, vol. 12, no. 19, May 6, 1920, pp. 506-510. Discussses organization and equipment required for (1) regular express services; (2) irregular services; and (3) aerial survey. Paper read before Royal Aeronautical Soc.

Developments in

Developments in Aviation (Aus der Entwicklung des Flugwesens). Schweizerische Bauzeitung, vol. 75, nos. 13, 14 and 15, Mar. 27, Apr. 3 and 10, 1920, pp. 139-144, 155-160 and 170-173, 35 figs. Discussion of the fundamental theory of aviation, followed by details and illustrations of design and construction parts of modern aeroplanes.

Desiderata in U. S.

Stimulating the Output of Airplanes in America. Automotive Industries, vol. 42, no. 22, May 27, 1920, pp. 1214-1215. Urges enactment of Federal aviation code, to be followed by concurrent legislation in all of several States, also establishment of air harbors for both land and water craft and development of system of meteorological and radio information for commercial aircraft.

Transcontinental Flying

Transcontinental Flying, P. D. Acland. Aeronautical Jl., vol. 24. no. 114, June 1920, pp. 273-288 and (discussion) 289-293. Résumé of principal flights undertaken by British Air Ministry during 1919.

B

BALANCING

Dynamic

Dynamics of Dynamical Balancing (In Japanese), I. Okamura. Denki Gakkwai Zasshi, no. 381, Apr. 10, 1920.

Turbines and Propellers

Balancing of Turbines and Propellers, J. J. King-Salter. Eng., vol 109, no. 2832, Apr. 9, 1920, pp. 491-494, 14 figs. Also Engr., vol. 129, no. 3354, Apr. 9, 1920, pp. 381-383, 4 figs. Machine for determining amounts and positions of weights required to balance turbine rotors, marine propellers, etc. System of collars with plunger pins passing through them is applied to rotor in such a way that extent to which pins are, after running, found to have been pushed in or out indicates position of out-of-balance weight. Paper gives vibration diagrams of S. S. Niagara, 525 ft. by 66¼ ft. by 34½ ft., 13,415 tons gross, obtained both before and after dynamically balancing center propeller. Paper read before Instn. Naval Architects.

[See also LOCOMOTIVES, Wheel-Balancing Machine.]

BALLOONS

Avorio-Prassone Kite Type

The Avorio-Prassone Kite Balloon, John Jay Ide. Aviation, vol. 8, no. 8, May 15, 1920, pp. 314-316, 6 figs. This type was used extensively for observation purposes by Italian Army. Gas envelope is ellipsoidal or ovoidal, depending upon model, with major and minor axes differing only slightly in length. Wind resistance of balloon is reduced by air-filled cone attached to rear end of envelope.

BEAMS

Reinforced-Concrete

Field Beam Tests by Reclamation Service, W. H. Fisher. Concrete. vol. 16, no. 5, May 1920, pp. 236-237. Field tests of reinforced-concrete beams being made on Northport unit of North Platte project, U. S. Reclamation Service. In all cases marked increase of strength was shown by those beams covered with sand while curing as compared with beams of same age and mix that were left exposed to weather.

Rapid Computation of the Dimensions of Reinforced-Concrete Beams (Détermination rapide des dimensions a donner aux poutres en bêton armé), Henri Kampmann. Génie Civil, vol. 76, no. 21, May 22, 1920, pp. 470-472, 6 figs. Simplified approximate design formulæ.

BEARING METALS

Substitute

Experiments with Substitute Bearing Metals at the Dockyard Laboratory of the Aviation Arsenal in Vienna (Versuche mit Ersatz-Lagermetallen bei dem Werst-Laboratorium des Fliegerarsenal in Wien), H. Praetorius. Motorwagen, vol. 23, no. 3, Jan 31, 1920, pp. 44-46. Results of wartime experiments with aluminum, zinc and lead bearing alloys.

Tests of

Properties of White Metals with Special Reference to Those Standardized by the Chamber of Mines' Committee, G. G. Elliott. Jl. South African Instn. of Engrs., vol. 18, no. 9, Apr. 1920, pp. 152-164, 15 figs. Tests of bearing metals. Photomicrographs of various mixtures are shown and interpreted.

BEARINGS, BALL

Manufacture

Ball-Bearing Manufacture — I. Machy. (Lond.), vol. 16, no. 396, Apr. 29, 1920, pp. 93-96, 7 figs. Description of methods used by the Hoffmann Manufacturing Co., Ltd., for producing balls, races and cages.

Naval Machinery

Use of Ball Bearings in Naval Machinery (L'emploi des roulements a billes dans les constructions navales), H. Bursée. Génie Civil, vol. 76, no. 22, May 29, 1920, pp. 487-490, 13 figs. Advantages of ball bearings over other types are indicated by graphs showing for each bearing variation of coefficient of friction with load.

[See also STEEL, HEAT TREATMENT OF, Ball Bearings.]

BEARINGS, ROLLER

Disk Type

Some New Anti-friction Bearings. Motor Traction, vol. 30, no. 796, May 31, 1920, pp. 540-541, 8 figs. Disk type in which tread surface of each roller is profiled to elliptical curve so that the roller constitutes an ellipsoid with ends cut off.

BELTS

Tension Rollers

Tension Rollers for Driving Belt, C. Bender. Eng. & Indus. Management, vol. 34, no. 19, May 12, 1920, p. 560. Essential feature in use of tension rollers or pulleys in belt driving is said to be that they should be placed close up against smaller belt pulley, and mounted so as to swing freely against slack side of belt and force latter to embrace largest possible arc on pulley. Details and illustrations of several arrangements. (Translated from Zeitschrift des Vereines deutscher Ingenieure).

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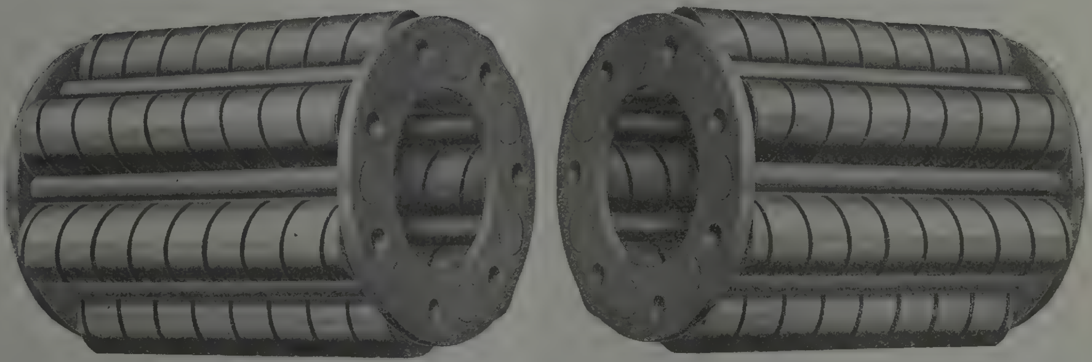


BLAST-FURNACE GAS

Power from

The Production of Power from Blast Furnace Gas, S. F. Fowles. Eng., vol. 109, no. 2831, Apr. 2, 1920, pp. 443-445, 3 figs. Diagram of Halberger-Beth gas cleaning plant. With waste crude gas from three furnaces, hot stoves are kept fully supplied with clean gas and consume about 1,000,000 cu.ft. per hr., and boilers are fully supplied with clean gas and consume about 0.6 million cu.ft. of clean gas per hour. Paper read before Instn. Elec. Engrs.

BLAST FURNACES

British Practice

British Blast-Furnace Practice, Fred. Clements. Iron & Steel Inst., Paper 3, Annual Meeting, May 6 & 7, 1920, 24 pp., 6 figs. Chemical and thermal balance sheets of basic furnaces, are presented and also scheme of blast-furnace operation in English steel works.

Chemical and Thermal Reactions

The Chemical and Thermal Conditions in Blast-Furnace Practice, H. E. Wright. Iron & Steel Inst., Paper 11, Annual Meeting May 6 & 7, 1920, 21 pp., 1 fig. Based on work of Sir Lowthian Bell.

BLASTING

See EXPLOSIVES.

BOILER FIRING

Oil vs. Coal

Will Fuel Oil Continue to be Burned for Steam Making? Eugene McAuliffe. Oil News, vol. 8, no. 13, June 5, 1920, pp. 31-36. Urges that work of shifting back to coal be begun at once because, it is claimed, oil resources of United States are being rapidly exhausted.

[See also BLAST-FURNACE GAS, Power from; PULVERIZED COAL, Cost of Preparation; STOKERS.]

BOILER PLANTS

Efficient Operation

Modernization of Stationary Boiler Plants. Ry. Age (Daily Edition), vol. 68, no. 23b, June 10, 1920, pp. 1638-1644, 3 figs. It is suggested to eliminate air infiltration by plugging cracks and applying commercial boiler seal, to apply adjustable dampers in uptake of each boiler to permit draft control, to apply differential draft gage to each boiler, to institute system of periodical inspection of grates, brick walls and baffles, etc. Question of using pulverized coal is discussed and also that of using furnace designed to burn crushed coal. Committee report presented at meeting of Mechanical Section, American Railroad Assn.

BOILERS

Heating, Cracking of

The Cracking of Cast-Iron Sectional Boilers (Das Zerspringen der gusseisernen Gliederkessel). Gesundheits-Ingenieur, vol. 42, no. 52, Dec. 27, 1919, pp. 525-526, 4 figs. Writer explains causes of cracks which, he claims, can be prevented by the equalization of the water temperatures and avoiding or reducing incrustration, and suggests how this can be accomplished.

BOLTS

Standards for

Standards for Bolts, Machine Screws and Nuts of 2.5-mm. to 12-mm. Diameter Established by the Union of Electrical Syndicates (Unification des boulons, vis et écrous décolletés de 2.5 à 12 mm de filetage établie par l'Union des Syndicates de l'Electricité). Revue générale de l'Électricité, vol. 7, no. 17, April 24, 1920, pp. 556-558, 1 fig. Notable feature of standards is sensible reduction of heads. Standards were adopted on Jan. 7, 1920.

BONUS SYSTEMS

Maxi-Pay Plan

A Bonus Plan that Works, Fred H. Colvin. Am. Mach., vol. 52, no. 22, May 27, 1920, pp. 1137-1139. Maxi-Pay production bonus plan based upon allotment of established standard time for unit production. Experience of Bullard Machine Tool Co., Bridgeport, Conn.

BORING

Earth-Piercing Machine

Thrust Boring in Earth. Engr., vol. 129, no. 3354, Apr. 9, 1920, pp. 369-371, 4 figs. Machine invented by Capt. A. R. Mangnall and made by Hydraulic Eng. Co., Chester, England, which is said to be built to pierce a hole 4 in. in diameter and 150 ft. long horizontally through heavy clay in half an hour. Machine is said to operate on principle of thrusting a stick into clay.

BRASS

Specifications

The General Aspect of the Standardization of Metals and Alloys and the Status of the Present Work (Allgemeine Gesichtspunkte über Normung der Metalle und Legierungen und Stand der gegenwärtigen Arbeiten), H. Schulz. Metall u. Erz., vol. 17, no. 5, Mar. 8, 1920, pp. 119-125. Notes on the development of standards in machine construction and standardization of metals, with revised tables of specifications for brasses and bronzes. Address before Soc. of German Met. & Min. Engrs.

BRASS FOUNDING

Electric Furnaces for

More Casting Shop Troubles and the Answer, W. J. Pettis. Elec. Furnace, vol. 1, no. 45, April-May 1920, pp. 12-13 and p. 17, 1 fig. Suggestions in regard to selection of type of electric furnace for brass manufacture.

BRAKES

Air, Kunze-Knorr

Kunze-Knorr Continuous Compound Compressed Air Brake (Le frein continu compound a air comprimé système Kunze-Knorr), Lefeuvre. Génie Civil, vol. 76, no. 22, May 29, 1920, pp. 492-497, 52 figs, partly on supp. plate. System installed in German railway freight cars during war, and recently adopted by Swedish railways.

Train

Report on Brake Shoe and Brake Beam Equipment. Ry. Age, (Daily Edition), vol. 68, no. 24e, June 16, 1920, pp. 1851-1857, 9 figs. Designs proposed by Committee of Am. Railroad Assn., Mech. Section.

BREAKWATERS

Shape, Influence of

Investigations of the Influence of the Shape of Breakwaters on the Coast Current and Sand Shifting in Front of Harbor Entrances (Untersuchungen über die Einwirkung der Form der Molen auf Kustenströmung und Sandwanderung vor der Hafeneinfahrten), H. Musset. Zeitschrift für Bauwesen, vol. 70, no. 1-3, 1920, pp. 106-115, 2 figs. Results of investigations carried out in the Harbors of Colberg, Rügenwaldermünde and Stolpmünde.

BRIDGE ERECTION

See BRIDGES, RAILWAY, Kenova.

BRIDGES

Stress Recorder for

The Fereday-Palmer Stress Recorder. Eng., vol. 109, no. 2822, Jan. 30, 1920, pp. 138-139, 19 figs. Patented machine designed for determining stresses on bridge members.

BRIDGES, CONCRETE

Arch

Longest Concrete Arch Span Being Built at Minneapolis. Cement & Eng. News, vol. 32, no. 5, May 1920, p. 21, 1 fig. Arch will consist of two separate ribs of 400-ft. span between faces of piers, with rise of 88 ft. above springing line, at high-water level. Main arch is flanked at each end by one arch with clear span of 199 ft. and one of 55½ ft., total length of bridge over abutments being 1032 ft.

Girder

A Reinforced-Concrete Girder Bridge Over the Bregenzer Creek Near the Lake of Constance (Eine Eisenbetonbalkenbrücke über die Bregenzer Ache unweit des Bodensees), W. Kunze. Bauingenieur (Successor to Armierter Beton), vol. 1, no. 1, Jan. 15, 1920, pp. 19-20, 4 figs. Details of bridge 225 m. long with 1.22-m. elevated sidewalks on each side of 4.60-m. roadway, with eleven spans varying from 11 to 28 m.

[See also BRIDGES, HIGHWAY, Reinforced-Concrete.]

BRIDGES, HIGHWAY

Floor Joists, Load Concentrations on

Load Concentrations on Steel Floor Joists of Wood Floor Highway Bridges, T. R. Agg and C. S. Nichols. Official Publication of Iowa State College of Agriculture & Mechanic Arts, vol. 17, no. 48, April 30, 1919, 31 pp., 24 figs. Investigation undertaken to determine manner in which heavy wheel loads, such as those of traction engines, are distributed to various I-beams and channels in highway-bridge floor system. It was found that concentration on single floor joist, equal to 55 per cent of one wheel load, is possible where single thickness of wood floor is laid on steel floor joists. Effects of loosening ends of plank, placing second layer of floor planks, etc., were also investigated.

Reinforced-Concrete

Reinforced Concrete Highway Bridges. Public Works, vol. 48, no. 19, May 22, 1920, pp. 442-444. Details of design, specifications and construction which should be studied with view to developing and standardizing practice in this branch of highway work, as proposed by chairman of committee of Am. Concrete Inst.

BRIDGES, MASONRY

Morocco

Masonry Bridges at Morocco (Construction de ponts en maçonnerie, au Maroc). Génie Civil, vol. 76, no. 17, Apr. 24, 1920, pp. 385-390, 10 figs. Structural details of types built after Séjourné design over the Petrusse at Luxemburg. They consist of two or three parallel arches carrying flag-stone pavement. From Annales des Ponts et Chaussées.

BRIDGES, RAILWAY

Baltimore and Ohio

Baltimore & Ohio Builds New Main Line Bridge, H. A. Lane. Ry. Age, vol. 68, no. 22, May 28, 1920, pp. 1504-1506. Replacement of Allegheny River crossing at Pittsburgh, Pa., necessitated by traffic conditions. Improvement involved truss and girder spans over total length of 2122 ft. across river to an abutment forming end of new structure.

Kenova

Kenova Bridge Channel Span Erection, Public Works, vol. 48, no. 19, May 22, 1920, pp. 437-439, 4 figs. Cantilever erection of 518-ft. center span outside of old span under traffic. Adjacent anchor spans moved longitudinally and heavy girder ties shortened for erection adjustments. Center panel erection connections adjusted by jacking up ends of connected spans.

Movable

International Contest for Designs for a Railroad Bridge Over Arsta Bay Near Stockholm (Der zwischenstaatliche Wettbewerb für Entwürfe zu einer Eisenbahnbrücke über die Arstabucht bei Stockholm), H. Schaper. Bauingenieur (successor to Armierter Beton), vol. 1, no. 1, Jan. 15, 1920, pp. 3-9, 15 figs. Plans call for a movable bridge, 600 m. long, opening to a width of 24 m. for passage of high-masted ships, with superstructure of iron or concrete, or both. Details and illustrations of the three prize-winning designs and of the four designs bought by the railroad administration are given. (To be continued.) See also article by H. Kayser, Zentrallblatt der Bauverwaltung, vol. 40, nos. 9, 11 and 12, Jan. 31, Feb. 7 and 11, 1920, pp. 53-56, 65-69 and 73-76, 34 figs. (To be continued.)

BRIDGES, STEEL

See BRIDGES, RAILWAY, Baltimore & Ohio.

BROACHES

Tooth Sizes

Graphical Method of Designing Broaches, George C. Hanneman. Machy (N. Y.), vol. 26, no. 9, May, 1920, pp. 823-824, 5 figs. Method for determining diameter or size of any tooth of a broach after total amount of stock to be removed has been determined.

BRONZE CASTINGS

Elastic Properties

Elastic Properties of Bronze Castings, George F. Comstock. Chemical & Metallurgical Eng., vol. 22, no. 24, June 16, 1920, pp. 1113-1118, 4 figs. Tests are quoted in which definite proportional limit was easily determined for bronzes, and suggestion is made that this test should replace "yield point" determinations.

BRONZES

Specifications

See BRASSES, Specifications.

BUILDING CONSTRUCTION

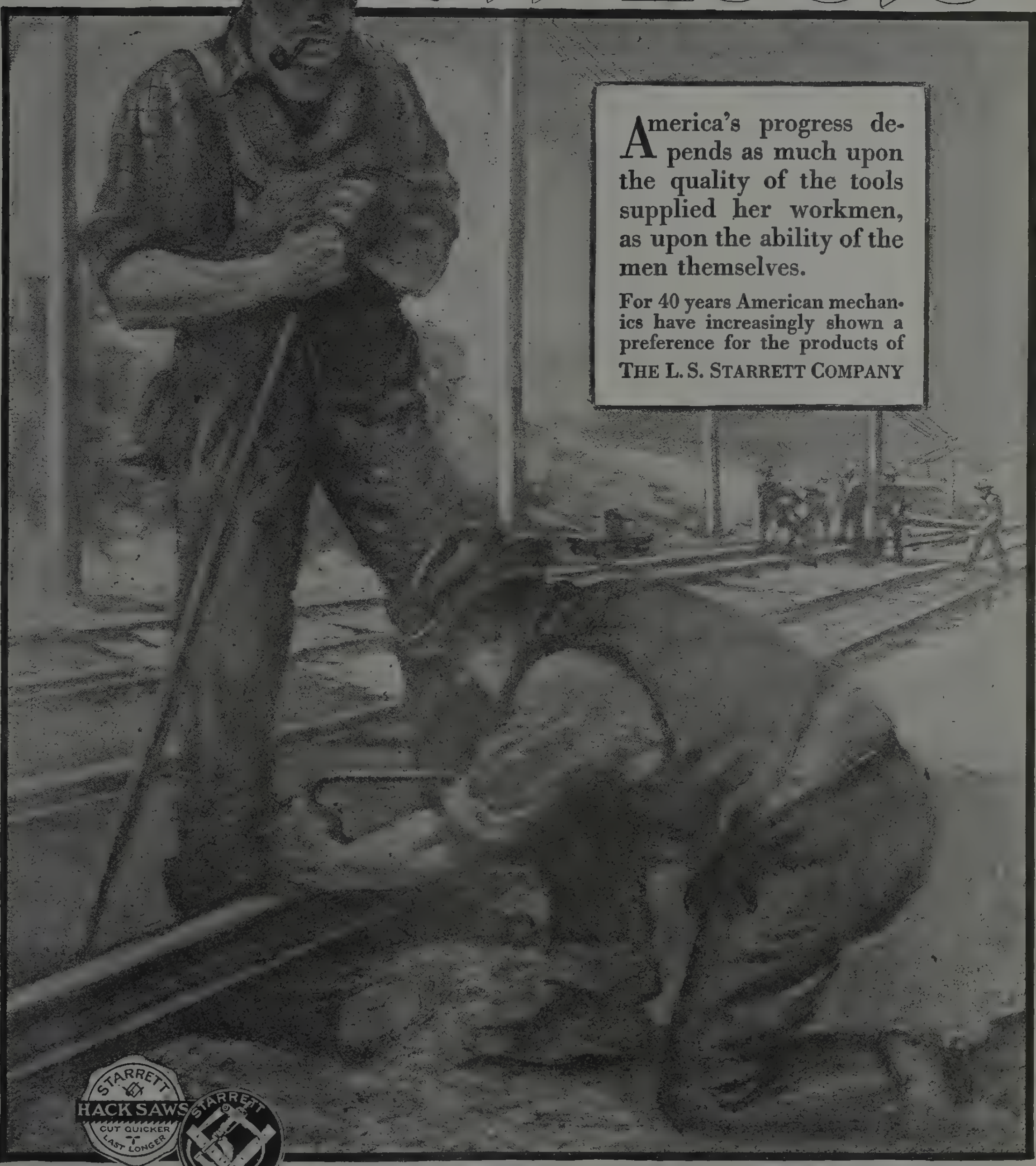
Cost Estimating

Elements That Must Be Considered in Cost Estimating. Eng. & Contracting, vol. 53, no. 20, May 19, 1920, pp. 567-569. Report of Committee on Cost Estimating of Northwestern Assn. of Gen. Contractors.

Olympia Exhibition

The Building Exhibition at Olympia. Eng., vol. 109, no. 2833 and 2834, April 16 and 23, 1920, pp. 518-519 and 556-557, 3 figs. Briquetting press, concrete-tile machine and concrete road-making machine.

Starrett Tools



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Starrett Hack Saws

42-63

ENGINEERING INDEX (Continued)

C

CABLES, ELECTRIC

Energy Loss in Dielectric

Energy Loss in the Dielectric of Industrial Cables (Sur la perte d'énergie dans le diélectrique des cables industriels), G. Renneson. Revue générale de l'Électricité, vol. 7, no. 18, May 1, 1920, pp. 579-581, 3 figs. Experimental. It was found that (1) at constant temperature and frequency, losses are proportional to square or power 2.5 of voltage, and (2) at constant voltage and frequency, losses diminish at first up to 30 deg., where there is a minimum, and increase to 60 deg., limit to which experiments were carried.

Overvoltages

Overvoltages in Armored Cables and How to Prevent Their Occurrence (Surtensions par câbles armés et les moyens d'y parer), P. Bougherot. Revue générale de l'Électricité, vol. 7, no. 21, May 22, 1920, pp. 675-689, 7 figs. Computation of overvoltage occurring in long armored cable carrying alternating current when cable becomes grounded at or near the end of the line. Attention is directed to overvoltage produced by magnetic saturation of straining straps.

Submarine

The Magnetic Field of an Ocean Cable Fed with Alternating Current (Das magnetische Feld eines mit Wechselstrom gespeisten Seekabels), H. Lichte. Elektrotechnische Zeitschrift, vol. 41, no. 5, Jan. 29, pp. 88-90, 16 figs. Results of experiments carried out in 1918 to determine course of magnetic field over surface of water in vicinity of cable, the distortion of field caused by iron ship hulls, and the influence of length of cable and depth of water on intensity of magnetic field. Report from laboratory of Submarine Signal Department of the Torpedo Inspection Board at Kiel.

CAMS

Design

Cam Design and Construction—XI and XII. Franklin DeR. Furman. Am. Mach., vol. 52, nos. 19 and 22, May 6 and 27, 1920, pp. 987-999. 13 figs., and 1129-1135, 16 figs. Elliptical arc for rolling cams. Effect of swinging transmitter arm between ordinary radial cam and follower.

CAR DUMPERS

Large-Capacity

Linn Mine-Car Dump is Largest in the World, Ralph W. Mayer. Coal Age, vol. 17, no. 22, May 27, 1920, pp. 1085-1088, 10 figs. Dump is nearly 300 ft. long and is operated by compressed air. By it, it is said, 28 cars in single trip may be discharged simultaneously.

CAR WHEELS

Chilled-Iron

Manufacturing Chilled Iron-Car Wheels—VI, H. E. Diller. Foundry, vol. 48, no. 12, June 15, 1920, pp. 481-483, 5 figs. Procedure for small wheels.

CARBURETORS

Claudel

The Claudel Carburetor. Aviation, vol. 8, no. 8, May 15, 1920, pp. 324-326, 7 figs. Tube automatic compensating carburetor without moving parts.

Metering Characteristics

Metering Characteristics of Carburetors, Percival S. Tice and H. C. Dickinson. Nat. Advisory Committee for Aeronautics, no. 49, 1919, 55 pp., 46 figs. Among results found in experimental tests are: Control of range of mixture ratios delivered by carburetor is obtainable by simple selection of ratio of length to diameter for fuel metering passage; coefficient of discharge has almost constant value for throat velocities greater than 145 ft. per second; effect upon carburetor capacity of usual rates and amplitudes is practically negligible; mixture ratio for maximum power is practically constant at all air densities; and ordinarily employed variations in structure and in method of fuel control in carburetors effect inappreciable modifications of altimetric compensation.

CARS

Journal Boxes

Standard Method of Packing Journal Boxes. Ry. Age, Daily Edition. vol. 68, no. 24, June 15, 1920, pp. 1807-1809, 1 fig. Method recommended by Committee of Am. Railroad Assn., Mech. Section.

Oscillations on Curves

Recommendations for the Mitigation of Detrimental Oscillations of Railroad Cars on Curves (Gedanken und Vorschläge zur Milderung der nachteiligen Schwankungen der Eisenbahnfahrzeuge in den Gleiskrummungen), G. Maas. Annalen für Gewerbe u. Bauwesen, vol. 85, no. 12, Dec. 15, 1919, pp. 98-100, 5 figs. Description and illustrations of a car so constructed that when rounding a curve the axles assume position of radii to the curve.

CARS, FREIGHT

Double Bolster

The Double Bolster Wagon. Ry Gaz., vol. 32, no. 20, May 14, 1920, pp. 721-722. Type which can be used either as 12-ton ordinary freight car or as double bolster.

CEMENT GUN

Covering Mine Buildings

Gunite Forms an Excellent Material for Covering Mine Buildings. Coal Age, vol. 17, no. 24, June 10, 1920, pp. 1185-1188. Frame buildings with gunite covering, it is claimed, are cheaper than cement structures covered with sheathing and clapboards and nearly fireproof, only the trim requiring repainting.

CEMENT, PORTLAND

Blast-Furnace Slag

Iron Portland Cement, with Classification of Cements Made from Blast-Furnace Slag, Edwin H. Lewis. Iron & Steel Inst., Paper 6, Annual Meeting, May 6 and 7, 1920, 10 pp. Cements made from blast-furnace slag are divided into five classes: (1) Blast-furnace slag as cement: (2) slag cements; (3) portland cement; (4) improved slag cement; and (5) iron portland cement. How far iron portland cement can comply with tests required in British standard specification for portland cement is indicated.

CENTRAL STATIONS

Annual Load Factor

Developing the Electrical Possibilities in Arkansas. Elec. World, vol. 75, no. 22, May 29, 1920, pp. 1265-1267, 6 figs. How combination of seasonal loads and ordinary commercial lighting and power loads gives high annual load factor to Arkansas Light & Power Co.

Power Factor

The Power Factor of Central Stations (La question du facteur de puissance), Pierre Dumartin. Revue générale de l'Électricité, vol. 7, no. 20, May 15, 1920, pp. 643-656. Methods of improving power factor are discussed. Judicious combination of synchronous motors and phase compensators installed at places where energy is consumed, is preferred.

Superpower

Design of a Superpower Station, H. Goodwin, Jr. Gen. Elec. Rev., vol. 23, no. 5, May, 1920, pp. 399-418, 15 figs. Method of designing is exemplified by working out case of steam-turbine generating station of 245,000-kw., 300,000-kva. capacity and 66,000-volt distribution.

Proposed Super-Power Central Station, John A. Stevens. Power, vol. 51, no. 21, May 25, 1920, pp. 832-836, 3 figs. partly on supp. plate. Proposed design of super-power station built with multiples of 30,000-kw. units up to total station capacity of any value between 100,000 kw. and 500,000 kw. Each unit consists of four 1716-hp. boilers, normal rating, served by one stack centrally located and supplying steam to one 30,000-kw. turbine. All boiler houses are separated from their turbine rooms by explosion gap and turbine rooms are separated by explosion walls.

CENTRIFUGAL TESTING PLANTS

See STEAM TURBINES, Centrifugal Testing Plants.

CHARCOAL

Heat Treatment of

The Activation of Wood-Charcoal by Heat Treatment, James C. Philip, Sydney Dunnill and Olive Workman. Jl. Chem. Soc., vol. 117 and 118, no. 690, April, 1920, pp. 362-369, 2 figs. Account of experiments on absorptive power of wood charcoal for (1) sulphur dioxide, and (2) methylene blue in aqueous solution.

CHEMICAL ANALYSIS

Metals, X-Ray

Analysis by X-Rays. Eng., vol. 109, no. 2829, Mar. 19, 1920, pp. 365-366, 7 figs. Survey of recent developments in analysis of metals. Paper read before Röntgen Society.

CHROME-NICKEL STEEL

Physical Properties, Initial Temperature and

The Effect of Initial Temperature Upon the Physical Properties of Steel, J. H. Andres, J. E. Rippon, C. P. Miller and A. Wragg. Iron & Steel Inst., Paper 18, Annual Meeting, May 6 & 7, 1920, 82 pp. 76 figs. Effect of variation in initial temperature upon position of resulting transformation points in certain nickel, chromium and chrome-nickel steels was experimentally determined. Volume change at normal transformation points was found to be composed of two changes working in opposition, allotropic change and change due to carbide. It is stated that quenching merely stereotypes condition of carbide, which, in its turn controls allotropic change. In general, it is believed that steels behave in much the same way as carbon steels, excepting that in latter time factor necessary to produce same changes in carbide is of much lower order.

CHROMIUM STEEL

Properties

The Properties of Iron-Chromium Carbon Steels—I, C. A. Edwards, H. Sutton and G. Oishi. Iron & Steel Inst., Paper 14, Annual Meeting, May 6 & 7, 1920, 44 pp., 8 figs. Temperatures at which carbides go into solution when steels are heated and those at which reverse change takes place on cooling were experimentally determined. Results found, which are given in tabulated and diagrammatic forms, indicate that temperature at which carbides separate from solution during cooling is raised by increased chromium and carbon content of steel.

Chromium Steels.—II, C. A. Edwards and A. L. Norbury. Iron & Steel Inst., Paper 14, Annual Meeting, May 6 & 7, 1920, 36 pp., 9 figs Experimental determination of effect of heat treatment on electrical resistivity. It is concluded that in annealed condition effect of chromium is to raise resistivity of iron by 3.75 microhms for each 1.0 per cent in excess of 4.3 times carbon content.

Structure

The Structure of Some Chromium Steels, J. H. G. Monypenny. Iron & Steel Inst., Paper 16, Annual Meeting, May 6 & 7, 1920, 26 pp. 18 figs. Experiments with chromium steels containing between 1.5 and 15 per cent chromium. Properties of these steels were found to change progressively with increasing amounts of chromium. Most abrupt change was in production of austenite on quenching from high temperatures, limiting compositions giving this constituent having been fairly sharply defined. Rate of diffusion of carbides in chromium steels was found to be much lower than in ordinary steel, and chromium lowered carbon content of eutectoid point considerably and also decreased solubility of cementite in austenite.

CITY PLANNING

See TOWN PLANNING.

COAL

Analysis of

Notes on Coal Analysis, F. S. Sinnatt. Lancashire & Cheshire Coal Research Assn., Bul-4, 1920, 38 pp., 2 figs. Bulletin prepared for information of members of Coal Research Association. Writer is director of research to association. Special attention is given to purchasing coal upon scientific foundation.

Fixed Carbon Content and Petroleum

Carbon Ratios in Carboniferous Coals of Oklahoma, and Their Relation to Petroleum, Myron L. Fuller. Economic Geology, vol. 15, no. 3, April-May, 1920, pp. 225-235, 1 fig. Reference is made to theory advanced by David White concerning relation between percentage of fixed carbon in pure coal and presence of oil in region in which coal occurs. Map is shown with lines separating areas in which there is possibility of oil being present from regions in which there is no such possibility.

Iowa and Illinois

Locomotive Tests with Iowa and Illinois Coals. Official Publication of Iowa State College of Agriculture & Mechanic Arts, vol. 15, no. 34, April 20, 1917, 40 pp., 16 figs. Object of investigation was to determine relative values of Iowa and Illinois coals under certain prescribed conditions. Proximate and calorific analyses showed little difference on dry basis, but Iowa coal contained more moisture than Illinois coal. Pounds of ash and refuse were higher with lower percentage of carbon for runs with Illinois coal. Boiler and grate efficiency was higher with Iowa than with Illinois coal. All averages of other factors of boiler and engine performance based upon coal fired show more favorable results with Iowa coal.

Early Purchase and Storage of Iowa Coal, L. C. Hodson. Official Publication of Iowa State College of Agriculture & Mechanic Arts, vol. 16, no. 35, Jan. 30, 1918, 8 pp. Urges early purchase and storage of coal by domestic consumers in order to maintain steady mining transportation.

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ENGINEERING INDEX (Continued)

Thermal Decomposition

Researches on Coal, S. Roy Illingworth. Jl. Soc. Chem. Indus., vol. 39, no. 9, May 15, 1920, pp. 111T-118T, 7 figs. Thermal decomposition of coal at low temperatures. It was found that decomposition of coals at temperatures up to 450 deg. cent. results in destruction of pyridine soluble constituents of coal substance.

COAL BREAKERS

New Type

An Anthracite Breaker That Is Different, Dever C. Ashmead. Coal Age, vol. 17, no. 21, May 20, 1920, pp. 1039-1042, 4 figs. Features quoted as distinctive are separation of rock outside main breaker, special type of shaker screen, combination of mechanical pickers and jigs and system of motor drive controlled from central point.

COAL HANDLING

Labor-Saving Methods

Handling the Factory Coal Pile, Charles L. Hubbard. Factory, vol. 24, no. 9, May 15, 1920, pp. 1531-1536, 17 figs. Writer points out that better ways of storing and distributing fuel usually involve less manual labor and more mechanical work, which means less expense and greater dependability, and describes coal-handling plans for many conditions.

Labor-Saving Methods of Handling Cars at Anthracite Shaft Stations, Dever C. Ashmead. Coal Age, vol. 17, no. 21, May 20, 1920, pp. 1052-1055, 5 figs. Equipment at mine of Silver Creek colliery of Philadelphia & Reading Coal & Iron Co.

Plant

An Interesting Installation of Coalhandling Equipment. Power Plant Eng., vol. 24, no. 11, June 1, 1920, pp. 557-558. Installation at United States War Department's Old Hickory Smokeless Powder Plant, Nashville, Tenn. Total storage capacity is 100,000 tons and conveyors can handle maximum of 600 tons per hour from storage to bunkers.

Portable Bucket Elevator

A New Electrically Driven Device for Unloading and Piling Coal and Other Bulk Materials (Ueber eine neuartige elektrisch betriebene Entlade- und Stapelvorrichtung für Kohlen und andere Schüttgüter), Hubert Hermanns. Elektrotechnische Zeitschrift, vol. 41, no. 3, Jan. 15, 1920, pp. 55-56, 4 figs. Portable bucket elevator.

COAL INDUSTRY

Coal Prices

Costs Constitute the Only Fair Basis for Fixing Prices, Frank Wilbur Main. Coal Age, vol. 17, no. 22, May 27, 1920, pp. 1095-1096. In figuring costs, it is held, allowance should be made for reasonable wages for proprietors and equitable interest on capital invested. Standardized fundamental methods of cost accounting are advocated.

Labor Held Blameless for Price Increases. Coal Age, vol. 17, no. 22, May 27, 1920, pp. 1089-1091. It is held that increased wages to labor "are in no way responsible for increased prices" of coal. Fundamental cost of high prices is held to be profiteering by producers, middlemen and retailers. Statement by Railroad Brotherhoods in hearings before U. S. Railroad Labor Board.

Seasonal Freight Rates

Seasonal Freight Rates Will Affect Coal Fields in Varying Degrees, F. G. Tryon. Coal Age, vol. 17, no. 21, May 20, 1920, pp. 1033-1037, 4 figs. Diagrams comparing seasonal rates with production in various regions of United States and with average spot prices. From testimony presented by Director of Geological Survey at hearings on seasonal coal freight rate bill.

Stabilization

Stabilization of Coal Industry Depends on Improvement in the railroad Situation, Howard N. Eavenson. Min. & Metallurgy, no. 162, June, 1920, pp. 5-6. Experience of United States Coal & Coke Co. is quoted as illustrating present conditions. It is stated that although that company has capacity of 20,000 tons daily, only 12,000 tons on average can be produced owing to car shortage.

COAL MINES

Barrier Pillars

What Barrier Coal Has Been and Should Be Left to Protect Anthracite Mines—I. W. B. Richards. Coal Age, vol. 17, no. 22, May 27, 1920, pp. 1097-1101, 7 figs. Records several cases where barrier pillars were provided, what rock overburden and water pressure they sustained, their thickness, height and character and their ability to satisfactorily function. Some experience is given as to longitudinal draw.

Fires

Property Owners Try to Control a City Mine Fire by Strip Pit and Clay Bank, Donald J. Baker. Coal Age, vol. 17, no. 21, May 20, 1920, pp. 1043-1045, 7 figs. Fire in mine at Squirrel Hill district of Pittsburgh.

COAL MINING

Beds Separated by Stratum

Successful Methods of Working Two Coal Beds Separated by Six Feet of Slate, Dever C. Ashmead. Coal Age, vol. 17, no. 24, June 10, 1920, pp. 1189-1190, 9 figs. After mining lower bed, upper one was dropped and coal loaded out.

Electricity in

Electricity in Pierce County Coal Mines, E. J. Barry. Jl. Electricity, vol. 44, no. 11, June 1, 1920, pp. 565-567, 2 figs. Experience of company in Washington State.

Stripping

Estimation of Quantities Removed in the Stripping of Anthracite, Thomas F. Kennedy. Coal Age, vol. 17, no 25, June 17, 1920, pp. 1251-1253, 1 fig. Of three methods—square, prismoidal and average-end—latter is said to be preferred.

Where Stripping is Regarded as a Regular Adjunct to Underground Mining—II, Donald J. Baker. Coal Age, vol. 17, no. 24, June 10, 1920, pp. 1191-1194, 5 figs. General layout of strip pits and undeground mine of Rowland-Power Consolidated Collieries Power Plant near Terre Haute, Ind.

[See also SHAFT SINKING.]

COLD STORAGE

Operation and Maintenance

Cold Store Operation and Maintenance, E. L. Rees. Cold Storage & Ice Assn. Proc., vol. 16, no. 1, 1919-1920, pp. 49-57 and (discussion), pp. 58-69. A discussion of the rise in costs due to war. Rise of prices of coal and other accessories and especially of labor since 1914 is cited.

COMBUSTION

Air Required for

Air Required for Combustion, W. C. Stripe. Combustion, vol 2, no. 5, May, 1920, pp. 21-23, 2 figs. A graphic method is presented for determining quantity of air required for combustion and importance of maintaining proper relation of air and fuel is pointed out.

Surface

Surface Combustion, A. E. Blake. Proc. Engrs. Soc. Western Pa., vol. 36, no. 3, April 1920, pp. 145-174 and (discussion) pp. 175-204, 27 figs. Advantages of surface combustion are pointed out, and its applications in industrial purposes are illustrated. Bibliography is included. From book on American fuels by R. F. Bacon and W. A. Hamor, to be published by McGraw-Hill Book Co.

COMPASSES

Gyroscopic

The Gyrostatic Compass, Sydney G. Brown. Eng., vol. 109, no. 2824, Feb. 13, 1920, pp. 202-206, 10 figs. Description of Brown gyrocompass.

CONCRETE

Aggregate, Unit Weight of

Concrete and Concrete Aggregates. Report of Committee C-9, Annual Meeting, Am. Soc. Testing Matls., June 22-25, 1920, 46 pp. Comparative study of various methods for determining unit weight of concrete aggregate. Rod method is concluded to be "most useful and satisfactory." A tentative standard is proposed for unit weight of aggregate for cement concrete.

Flowability

Flowability of Concrete and Its Measurement by Means of the "Flow Table," G. M. Williams. Can. Engr., vol. 38, no. 24, June 10, 1920, pp. 545-547. Investigation in concrete laboratory of Bureau of Standards.

Miami Conservancy District

Concrete for Miami Conservancy District Work. Public Works, vol. 48, no. 21, June 5, 1920, pp. 487-490, 5 figs. Excavating, preparing, grading and storing aggregate. Testing and proportioning materials. Mixing and delivering concrete. Experimental determination of most desirable mixture of sand, gravel and mortar, with tables of voids and density for different sizes of aggregates.

CONDENSERS

Distillation, Test for

Condensers (Ueber Kühler), Fritz Friedrichs. Zeitschrift für angewandte Chemie, vol. 33, no. 8, Jan. 27, 1920, pp. 29-32, 6 figs. Review of different types of condensers, the most important of which are tested according to a method especially worked out. Efficiency of Soxhlet apparatus is found to be not in keeping with its cost; but spiral condensers, it is claimed, have a cooling effect which cannot readily be surpassed, and are feasible also as return-flow condensers.

CONVERTERS

Synchronous

60-Cycle Converting Apparatus, J. L. Burnham. Gen. Elec. Rev., vol. 23, no. 5, May, 1920, pp. 392-398, 12 figs. Devices which have been developed to prevent flashing of commutator when converters used for voltages of 500 and 600 are subjected to short-circuits or quick changes in load.

COPPER ALLOYS

Phosphorus-Copper

Fifteen Per Cent. Phosphor-Copper—New Process for Making, P. E. Demmler. Min. & Metallurgy, no. 162, June 1920, pp. 32-33. Uniform product is obtained, it is said, by passing phosphorus vapor over copper heated to temperature of 400 deg. cent.

COPPER METALLURGY

Smelter Slags

Copper and Magnetite in Copper Smelter Slags—I, Charles G. Maier and G. D. Van Arsdale, Chemical & Metallurgical Eng., vol. 22, no. 24, June 16 1920, pp. 1101-1107, 30 figs. Chemical and microscopic examination of series of representative slags, showing how copper losses occur, relation of magnetite to copper loss, behavior of converter slags in reverberatory furnaces and suggestions for reducing copper slag losses.

COPPER ORE

Porphyry Ores

Treatment Tests on Ores of Consolidated Coppermines Co., Robert Linton. Min. & Metallurgy, no. 162, June 1920, pp. 30-31, 1 fig. Tests made on porphyry ores are said to have demonstrated that recovery of 85 per cent can be made from or averaging 1.4 per cent copper, with ratio of concentration of at least 15 into 1, and with concentrates that carry less than 10 per cent moisture.

CORONA

Loss Tests

Some Corona Loss Tests, W. W. Lewis. Gen. Elec. Rev., vol. 23, no. 5, May 1920, pp. 419-426, 12 figs. Results of tests on 150-mile transmission line at potentials up to about 200,000 volts. Comparison is made between measured and calculated losses.

CORROSION

Iron and Lead Underground Pipe

Corrosive Action of Soils on Iron and Lead, L. A. Stenger. Chem. & Metallurgical Eng., vol. 22, no. 21, May 26, 1920, pp. 965-968, 1 fig. It is concluded from field and laboratory experiments that electrolysis of underground structures may be caused by definite conditions which are determinable by electrical measurements and study of environments. Method is suggested for prolonging life of iron structures in given soils. Long life of cast iron, it is pointed out, is due to its greater wall thickness.

[See also ALUMINUM, Corrosion; HOT-WATER SUPPLY, Piping, Rust Prevention in.]

COST ACCOUNTING

Overhead, Distribution of

Handling "Overhead"—A Plan That Avoids Red Tape, S. P. Keator. Factory, vol. 24, no. 8, May 1, 1920, pp. 1343-1346. It is said that distribution of overhead costs can be greatly simplified if a method and forms are devised to secure simple and accurate expense reports from the shop. Practice of one plant is explained.

COST SYSTEMS

Foundry

Standard Foundry Cost System—III. Foundry, vol. 48, no. 12, June 15, 1920, pp. 474-480. Depreciation rates for buildings and equipment.

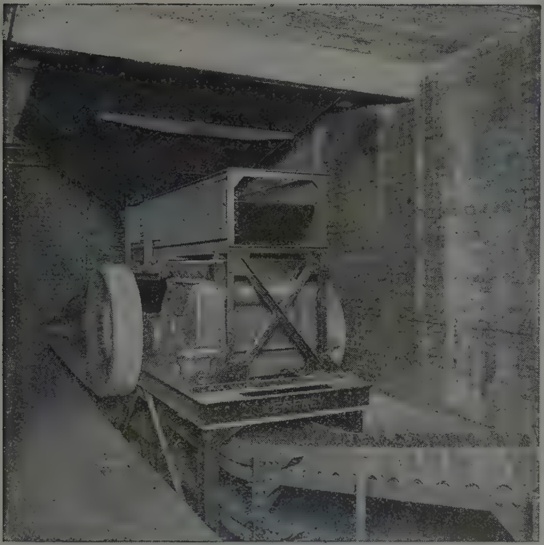
COSTS

Steam Power

See STEAM POWER PLANTS, Costs.

Woodworking

See WOODWORKING INDUSTRY, Costs.



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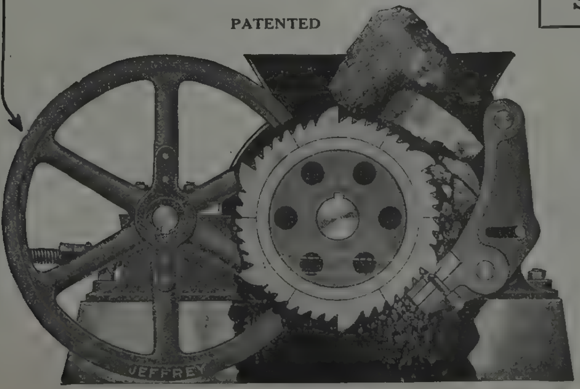

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ENGINEERING INDEX (Continued)

CRANES

Traveling

Five-Ton Electric Traveling Crane Moving Structural Steel by Means of Lifting Magnets (Pont roulant électrique de 5 tonnes pour le transport de profilés au moyen d'électro-aimants de levage). Génie Civil, vol. 76, no. 13, March 27, 1920, pp. 314-315, 4 figs, partly on supp. plate. Built at Oerlikon Works.

CUTTING METALS

Barth Slide Rules

Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—IX, Carl G. Barth. Indus. Management, vol. 59, no. 6, June 1920, pp. 483-486, 8 figs. Construction of machine-tool slide rules for shapers and slotters, including rocker-drive shaper, shapers and slotters with Whitworth quick-return motion.

D

DEHYDRATION

Commercial

Commercial Dehydration, Jonas E. Whitley. Jl. of Am. Soc. of Heat. & Vent. Engrs., vol. 26, no. 3, April 1920, pp. 341-352, 3 figs. Commercial possibility and economic advantages of dehydration are pointed out. Vacuum drying apparatus is sketched.

DETECTORS

See VACUUM TUBES, Uses as Detectors.

DIE CASTING

Methods of

Pressure and Vacuum Die Casting (Ueber Spritz- und Vakuumguss), Alfred Uhlmann. Giesserei-Zeitung, vol. 17, no. 2, Jan. 15, 1920, pp. 21-24, 6 figs. Details and illustrations of pressure and vacuum die-casting apparatus. Reference is made to a process worked out by writer for the cold die casting of certain metals.

DIES

Automobile Parts

Dies for Automobile Oil Filler Cup, J. Bingham. Machy. (Lond.), vol. 16, no. 395, Apr. 22, 1920, pp. 78-79, 5 figs. Description of dies used in manufacture of an oil-filler cup or breathing tube for automobile engine, an illustration of each die in the order in which it is used, and a detail of shell as it appears after each operation.

Dies for Automobile Silencer Housings. Machy. (Lond.), vol. 16, no. 396, Apr. 29, 1920, pp. 103-104, 6 figs. Description and illustrations of dies used to make the two shells which form housing for a certain type of automobile silencer.

Bending and Forming

Unusual Bending and Forming Dies, Frank A. Stanley. Am. Mach., vol. 52, no. 22, May 27, 1920, pp. 1127-1128, 4 figs. Dies for producing chute for coin-operated machine.

Motorcycle Parts

Dies for Shaping a Motorcycle Part, J. Bingham. Machy. (N. Y.), vol. 26, no. 9, May 1920, pp. 808-809, 7 figs. Drawing and forming dies required for manufacturing muffler cap of unusual shape.

DIESEL ENGINES

Cammellaird-Fullagar

The Cammellaird-Fullagar Marine Diesel Oil Engine. Eng., vol. 109, no. 2822, Jan. 30, 1920, pp. 144-146, 8 figs., partly on supp. plate. Two-cycle opposed-piston type. It is said that small space occupied by this engine permits its replacing steam engine and boilers of existing steamships without altering shafting or propellers.

Submarine

German Submarine Diesel Engines. Eng., vol. 109, no. 2836, May 7, 1920, pp. 613-614. It is stated that four-cycle engine was preferred in Germany for use in submarines because it involved fewer difficulties of construction and as it was more developed it was more reliable. Translated from "Schiffbau."

Trend in Marine Types

The General Trend of Diesel Marine Machinery. Eng., vol. 109, no. 2836, May 7, 1920, pp. 617-618. Survey of types being built in various countries.

DRAINAGE

Assessments for

The Assessment of Drainage Districts, Lewis E. Ashbaugh. Iowa State College of Agriculture & Mechanic Arts, vol. 5, no. 2, Nov. 1906, 18 pp. 2 figs. Principles are suggested for governing distribution of expenses over various tracts, and also arithmetical method for computing assessments. Principle followed is that "assessment must be proportionate to the benefits received."

Farm

Recommendations for Farm Drainage, W. J. Schlick. Official Publication of Iowa State College of Agriculture & Mechanic Arts, vol. 17, no. 19, Oct. 9, 1918, 24 pp. Graphs are included for computing capacities of tile drains based on calculations by Kutter's formula with $n = 0.015$.

DROP FORGING

Hammer Lubrication

Hammer Lubrication for Drop Forge Plant, R. V. Harty. Am. Drop Forger, vol. 6, no. 5, May 1920, pp. 244-246, 8 figs. Review of common practices of lubrication by hydrostatic and individual forced-feed systems. Advantages of central forced-feed system are enumerated.

DURALUMIN

See ALUMINUM ALLOYS.

DYES

Azo

New Basic Materials for the Production of Mordant Coloring Azo-Dyes (Ueber neue Ausgangsmaterialien zur Darstellung beizenfärbender Azofarbstoffe), Heinr. Bamberger. Zeitschrift für angewandte Chemie, vol. 33, no. 2, Jan. 6, 1920, p. 8. Writer explains that by reduction with sodium sulphate new derivatives are obtained that serve as valuable basic materials for certain azo-dyes adapted to production of metal compounds.

Triphenyl-Methane

Recent Theories of the Constitution of the Triphenyl-Methane Dyes (Neuere Ansichten über die Konstitution der Triphenylmethanfarbstoffe), G. Georgievics. Chemiker-Zeitung, vol. 44, no. 6, Jan. 13, 1920, pp. 41-43. Writer claims it has been shown that not all rosaniline dyes are found in uniform condition, and cannot therefore be determined by one and the same formula.

E

ECONOMIZERS

Advantages

Economizers, W. F. Wurster. Jl. Engrs. Club of Philadelphia, vol. 37-6, no. 187, June, 1920, pp. 323-325, 5 figs. Construction features are explained and advantages pointed out.

ELASTICITY

Strain-Energy Function

The Strain-Energy Function and the Elastic Limit, B. P. Haigh. Eng., vol. 109, no. 2822, Jan. 30, 1920, pp. 158-160, 5 figs. Technical analysis of published experimental determinations of elastic limits of different metals under two- and three-dimensional stresses.

ELECTRIC CIRCUITS, A.C.

Meter Connections

Switchboard Meter Connections for Alternating Current Circuits—VI, J. C. Group. Elec. Jl., vol. 17, no. 6, June 1920, pp. 251-253, 6 figs. Six-phase circuits.

Oscillatory

On the Period and Decrement of an Oscillatory Electrical Circuit Provided with a Short-Circuited Secondary, Iolo Jones. Lond., Edinburgh & Dublin Phil. Mag. & Jl. of Science, vol. 39, no. 233, May 1920, pp. 553-565, 8 figs. Mathematical study of effect on period and decrement of oscillation of system, of varying resistance of short-circuited coil.

ELECTRIC CONDUCTORS

Resistance

Section-Length-Resistance Relations of Conductors, E. B. Merrill. Elec. News, vol. 29, no. 10, May 15, 1920, pp. 30-31, 1 fig. Chart showing interrelation of resistance, length and cross-section of various conductors. Arranged for determining resistance of various sizes of wire of principal metals for lengths from 0.01 ft. to 1000 miles.

ELECTRIC DRIVE

See ROLLING MILLS, Electrically Driven.

ELECTRIC FURNACES

Arc, Electrode Control

Automatic Control of Arc Furnace Electrodes, J. A. Seede. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June 1920, pp. 593-597, 7 figs. Methods of electrode regulation.

Heat-Treating

Metallic Resistor Electric Furnaces for Heat Treating Operations, E. F. Collins. Gen. Elec. Rev., vol. 23, no. 5, May 1920, pp. 433-441, 16 figs. Types are described in which heat element consists of bare exceptionally heavy metallic ribbon uniformly distributed over interior of furnace.

Improvements in

The Direct Connection of Electric Steel Furnaces with Central Stations (Der unmittelbare Anschluss von Elektrostahlöfen an öffentliche Elektrizitätswerke), E. Fr. Russ. Elektrotechnische Zeitschrift, vol. 41, no. 3, Jan. 15, 1920, pp. 45-48, 5 figs. After calling attention to improvements and possibilities of improvements for obtaining a quiet operation of electric arc furnaces, writer divides them into three groups, namely, the radiation furnace, the arc-resistance furnace without additional heating, and the arc and resistance furnace with additional heating, and describes each of these groups.

Reactors for

Reactors for Electric Furnace Circuits, Harry A. Winne. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June 1920, pp. 589-592, 8 figs. Methods of introducing reactance into furnace circuits.

Resistance Type

Electric Furnaces of the Resistance Type for Heat Treating, T. F. Baily. Elec. Furnace, vol. 1, no. 45, April-May 1920, pp. 3-5 & pp. 18-19, 6 figs. Survey of types which have been built for heat-treating plants. Paper read before Detroit Chapter of Am. Soc. for Steel Treating.

Self-Baking Electrodes for

The Söderberg Self-Baking Electrode, Joseph W. Richards. Iron Age, vol. 105, no. 17, Apr. 22, 1920, pp. 1171-1173, 4 figs. Norwegian invention insuring continuous electrode supply to furnace. Describes how mixture is made and advantage of Söderberg electrode. From paper presented before Am. Electrochemical Soc. of Boston.

ELECTRIC GENERATORS, A.C.

Cooling

Temperatures in Large Alternating Current Generators, W. J. Foster. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June 1920, pp. 547-548. Calls attention to advantages resulting from drawing air into two ends of generator directly from dynamo room and piping it away in connection with hydraulic units.

High-Frequency

The Nauen 400-Kw. High-Frequency Generator Transmitter [Der Hochfrequenzmaschinen-Sender (400 MK) Nauen], H. Thurn. Telegraphen- und Fernsprech-Technik, vol. 8, no. 9, Dec., 1919, pp. 140-142, 5 figs. Inductor-type high-frequency generator consisting of a massive rotor without rotating winding and slip rings, delivering single-phase alternating current of 6000 cycles, which, by means of a pair of Joly type frequency changers can be increased to 24,000 cycles.

Lubrication

Vertical-Shaft Waterwheel-Driven Alternators—Lubricating System and Rotor, S. H. Mortensen. Power, vol. 51, no. 21, May 25, 1920, pp. 837-839, 5 figs. Typical systems used to lubricate various bearings of vertical alternator; influence of flywheel effect on speed variation and dimensions of rotor; safe speeds and different rotor constructions.

[See also ELECTRICAL MACHINERY, Eddy Currents in Stator Windings.]

ELECTRIC GENERATORS, D.C.

See ELECTRIC WELDING, ARC, Generators for.

ELECTRIC LAMPS, INCANDESCENT

Switching to Reduced Voltage

An Automatic Switch for Street Lamps (Ein selbsttätiger Umschalter für Strassenbeleuchtung), L. Bloch. Zeitschrift für Transportwesen u. Strassenbau, vol. 36, no. 21, July 20, 1919, pp. 246-247, 2 figs. Description and illustrations of an automatic apparatus designed by the German General Electric Co. for the automatic switching of street lamps from full voltage to reduced voltage.

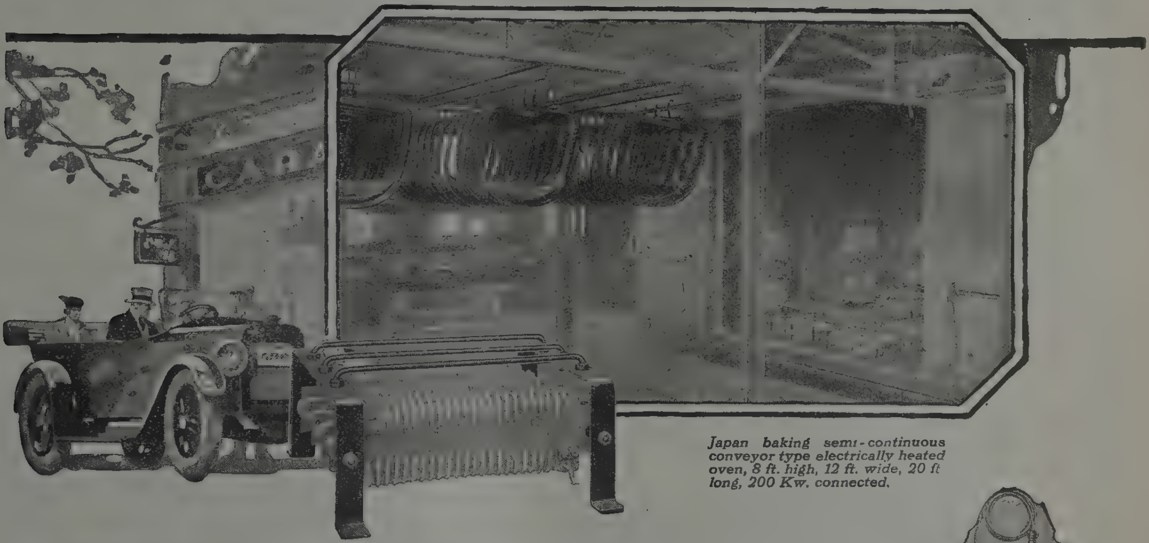
ELECTRIC LOCOMOTIVES

Chicago, Milwaukee & St. Paul

Layout of Apparatus in the Cab of the Chicago, Milwaukee & St. Paul Locomotives, C. C. Whittaker. Elec. Jl., vol. 17, no. 6, June, 1920, pp. 249-250, 3 figs. Diagram of weight distribution on locomotive cab frame.

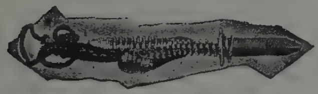
The Auxiliary and Lighting Control Equipment, John A. Clarke, Jr. Elec. Jl., vol. 17, no. 6, June, 1920, pp. 244-248, 10 figs. Auxiliary power is obtained from 35-kw. motor-generator set together with 378 ampere-hour storage battery.

Five years ago electric heat was somewhat of a novelty—today it is doing what was then considered impossible with any kind of heat



Japan baking semi-continuous conveyor type electrically heated oven, 8 ft. high, 12 ft. wide, 20 ft long, 200 Kw. connected.

Compound melting pot



Electric soldering iron

Electrically heated glue pot

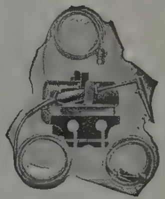
Beautiful Bodies Help Sell Motor Cars

ANY motor car builder will admit that a large number of cars is sold on "looks." As a result, the finishing of bodies and all enameled parts, such as fenders, wheels, tanks, etc., is a process that requires most careful consideration and the best equipment available.

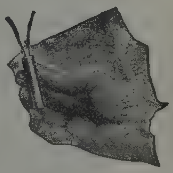
In this process, the electric oven has come to the front through its obvious advantages over old-fashioned methods of baking. Its use greatly increases production thereby reducing the unit cost, even with higher rates for power than for fuel. Electric heat produces a lustrous, hard finish so essential for lasting beauty, and it requires less time than other forms of heat, with more accurate control, greater safety, and practically no defective work that must be done a second time.

The flexibility of electric heat is remarkable since it permits the use of varying degrees of heat in different parts of the same oven or furnace. For this reason, electric heat is rapidly being applied to the baking of varnish, enamel, japan, and other finishes; to the melting of metals and alloys; to the heating of steel so that it may be chemically treated; to the drying of salts, sand cores, pottery and grinding wheels; to the heating of rivets, soldering irons, etc.; and even to the sherardizing of steel to make it rustproof by depositing on its surface a coating of zinc about twenty-five ten-thousandths of an inch thick.

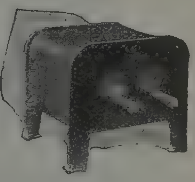
To every one of the many uses of electric heat the General Electric Company has contributed in a broad way, until today the mark G-E on any electric heating device is the mark of the master. Thus it is to any manufacturer's advantage to consult G-E engineers before selecting such equipment.



Pyrotip lead burner



Cartridge type electric heating unit



Soldering iron muffle furnace

General Electric Company

General Office
Schenectady, N.Y.

Sales Offices in
all large cities

39-40

ENGINEERING INDEX (Continued)

The Electrical Equipment and Control of the Chicago, Milwaukee & St. Paul Locomotives, P. L. Mardis. Elec. Jl., vol. 17, no. 6, June, 1920, pp. 235-244, 18 figs. Schematic diagram of control circuits and regenerative braking connections.

Swiss

Express Electric Locomotives for The Gothard Line of the Swiss Federal Railways. Tramway and Ry. World, vol. 47, no. 24, May 13, 1920, pp. 251-253, 11 figs. Two types, 2-6-2 and 2-4-4-2. Current is applied in single phase under pressure of 15,000/7,500 volts. Horsepower developed is 1650 hp. and 2250 hp., respectively.

New Electric Locomotives of the Swiss Federal Railways Built by Brown, Boveri & Co. (Les nouvelles locomotives électriques des chemins de fer fédéraux suisses équipées par la Société Brown, Boveri et Cie). Révue générale de l'Électricité, vol. 7, no. 17, April 24, 1920, pp. 563-568, 6 figs. Data: Single-phase current at 15,000 volts; four 540-hp. motors; diameter of driving wheels, 1350 mm.; total weight, 107.6 tons; maximum speed, 75 km. per hr.

ELECTRIC MOTORS, A.C.

Induction and Synchronous, Selection of

Induction and Synchronous Motors for Industrial Applications, C. W. Drake. Power, vol. 51, no. 20, May 18, 1920, pp. 822-823. Notes on selection of motors. Paper read before Pennsylvania Elec. Assn.

Single-Phase Commutator

Measurements of Single-Phase Commutator Motors (Die Abmessungen der Einphasen-Bahnmotoren), Franz Unger. Elektrotechnische Zeitschrift, vol. 41, no. 1, Jan. 1, 1920, pp. 3-7, 9 figs. The output coefficient of single-phase commutator motors based on output and torque is derived. Curves are given, based on permissible magnetic and electric stresses of copper and active iron, for permissible ratios of ampere-conduction per current armature circumference and induction in air, whereby Radt's investigations are used as basic principle. Curves are also given for the output coefficients.

Synchronous

Unity Power-Factor Synchronous Motor, W. T. Berkshire. Power, vol. 51, no. 21, May 25, 1920, pp. 850-851, 4 figs. Examples are worked out to show how 1000-kw. synchronous motor affects total kilovolt-ampere load on system when motor is operating at unity power factor, 0.80 power-factor leading, and 0.0 power-factor leading.

ELECTRIC PLANTS

Design

Influence of Wages on Power-Plant Design. Elec. Ry. Jl., vol. 55, no. 21, May 22, 1920, pp. 1043-1046, 8 figs. Complications in conversion of 3000-kw. station into one of 8000-kw. capacity in Charleston, S. C.

Economical Operation

Raising Economy in Prime Mover Practice. Elec. World, vol. 75, no. 22, May 29, 1920, pp. 1257-1260, 4 figs. Problems of burning low-grade fuels, oil engines and hydraulic practice are studied. Committee report presented at convention of Nat. Elec. Light Assn.

Exciter Systems

Considerations which Determine the Selection and General Design of an Exciter System. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 556-562. Symposium. Comparative study of various exciter systems.

Induction Regulators

Huge Induction Regulator Installation, Raymond Bailey. Elec. World, vol. 75, no. 24, June 12, 1920, pp. 1355-1358, 6 figs. Induction regulators installed by Philadelphia Electric Company, in order to permit operation of their 66,000-volt transmission lines at maximum load under all conditions. Regulators are rated at 1750 kva.

Stability

Stability of High-Power Generating Stations, Charles P. Steinmetz. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 554-556. Discusses power limitation devices and parallel operation of synchronous machines.

Swiss, Consolidation of

The Consolidation of Power Plants for the Purpose of Increasing Utilization of Energy (Der Zusammenschluss der Kraftwerke zum Zwecke erhöhter Energieausnützung), Bruno Bauer. Schweizerische Bauzeitung, vol. 75, no. 15, April 10, 1920, pp. 165-170, 7 figs. Discussion of the proposed scheme of the Zürich Assn. of Architects and Engrs. for the combination of all plants into one extended system of high-tension lines of great capacity, and also the combined utilization of all electric energy and opening up of new power sources. Paper read before the Zürich Assn. of Architects and Engrs.

ELECTRIC POWER

Farms, Advantages for

Transmitted Power for the Farm, F. C. Van Etten. Armour Engr., vol. 11, no. 3, March, 1920, pp. 195-207, 6 figs. Advantages of transmitted power over individual plant are enumerated, and economical features of electric transmission line for farm surveys are discussed.

ELECTRIC RAILWAYS

Austria

The Electrical Operation of the Austrian State Railroads (Elektrischer Betrieb der deutsch-österreichischen Staatsbahnen), H. Trautvetter. Elektrotechnische Zeitschrift, vol. 41, no. 3, Jan. 15, 1920, pp. 51-52. Recommendation of Austrian chief state councillor to employ alternating current of 50 cycles to be supplied by outside power plants is adversely criticised, and it is maintained that economic operation is possible with power supplied by railroad plants. The latest developments in construction of electric locomotives for the Prussian State Railroad are described.

Design, Maintenance and Operation

Design, Maintenance and Operation of Electric Rolling Stock. Elec. Ry. Jl., vol. 55, no. 24, June 12, 1920, pp. 1200-1205. Summary of present practices. Symposium of papers read at Mechanical Section Convention of Am. Ry. Assn.

Motor Cars

New Equipment for the Philadelphia Electrification, Walter H. Smith, Elec. Ry. Jl., vol. 55, no. 24, June 12, 1920, pp. 1207-1211, 11 figs. Motor is of commutating-pole type and control provides for protection without circuit breakers on cars. Specially designed screens are used to exclude dust from motors.

Suburban Lines

Maintenance of Single-Phase A. C. Multiple-Unit Equipment on the Westchester, Elec. Ry. Jl., vol. 55, no. 24, June 12, 1920, pp. 1193-1199, 14 figs. Inspection and maintenance practice on a high-speed suburban line, together with data covering costs of such inspection and maintenance.

ELECTRIC RAILWAYS, TRACK

Rail Joints

Methods and New Apparatus for Measuring the Resistance of Rail Joints (Méthodes et nouveaux appareils de mesure électrique des joints de rails), G. Lebaupin. Électricien, vol. 35, no. 1252, May 15, 1920, pp. 193-197, 5 figs. Application of principle of differential galvanometer. (To be continued.)

ELECTRIC SWITCHES

Disconnecting

Calculation of Magnetic Force on Disconnecting Switches, H. B. Dwight. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 550-552, 5 figs. Formulæ and graphs.

ELECTRIC TRANSMISSION LINES

Alternating-Current

Theorems Relative to Transmission of Energy by Alternating-Current Analagous to Siemens Theorem Concerning Transmission by Direct Current. Critical Study (Théorèmes sur les transmissions d'énergie par courants alternatifs analogues à celui de Siemens sur les transmissions par courant continu; critique de ces théorèmes), André Blondel. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 17, April 26, 1920, pp. 978-983. Siemens theorem to which reference is made is: Power transmitted by direct-current electric line cannot exceed value determined by ratio of four times resistance of line to square of voltage, and corresponding efficiency is only 50 per cent. Analagous theorem is established for alternating-current transmission lines. Developed theorem is shown to be applicable to electric lines of any length, however great.

High Tension

The 150,000-Volt Transmission Line of the Knoxville Power Company, Theodore Varney. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 563-670, 13 figs. Conductor is 500,000-cir. mil steel-reinforced aluminum cable.

Long-Distance

Long-Distance Electric Transmission Lines (Sur les lignes de transmission à grande distance), P. Bunet. Revue générale de l'Électricité, vol. 7, no. 21, May 22, 1920, pp. 700-707. Characteristics of half-wave lines. (To be continued.)

Overhead Cable Crossings

The Overhead Cable Crossing, J. F. Springer. Sci. Am., vol. 122, no. 22, May 29, 1920, p. 594 & p. 606, 4 figs. Span of 50,000-volt long-distance power-transmission line at Three Rivers, Quebec. Each tower is 350 ft. high and 60 ft. square at base. Span is 4801 ft. long.

Performance

Electrical Characteristics of Transmission Circuits—X, Wm. Nesbit. Elec. Jl., vol. 17, no. 6, June, 1920, pp. 257-263, 10 figs. Study of performance of long transmission lines by means of hyperbolic trigonometric functions.

Protection

Switching and Protection of Transmission Circuits—II, S. Q. Hayes. Elec. Jl., vol. 17, no. 6, June, 1920, pp. 263-271, 22 figs. Disconnecting switches and lightning arresters of electrolytic and horn-gap types.

Quarter-Wave Line

Transmission of Electrical Energy at Great Distances (Sur le transport de l'énergie électrique à grande distance), M. E. Brylinski. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 16, April 19, 1920, pp. 927-930. Equations of quarter-wave line.

Switzerland-France

Transmission of Hydroelectric Energy from Switzerland into France (Transport d'énergie hydro-électrique de Suisse en France), Paul Meyer. Révue générale de l'Électricité, vol. 7, no. 18, May 1, 1920, pp. 589-599, 18 figs. Line was designed to transmit 20,000 hp. a distance of 185 km. at 110,000 volts. Service is being provisionally rendered at 70,000 volts.

[See also CORONA, Loss Tests.]

ELECTRIC WELDING, ARC

Application to Structural-Steel Framing

Electric Arc Welding Applied to Structural Steel Framing. Am. Architect, vol. 117, no. 2319, June 2, 1920, pp. 707-711, 8 figs. Experimental and laboratory research work done by Elec. Welding Co. of America.

Automatic Apparatus

Automatic Arc Welding Apparatus, S. R. Bergman and R. L. Unland. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 536-537. Dynamo with drooping volt-ampere characteristic obtained by use of constant-potential generators with resistance in series with arc.

Floating Unit

Floating Electric Welder, R. Royal Roane. Int. Mar. Eng., vol. 25, no. 6, June, 1920, pp. 488-491, 7 figs. Dimensions: Length overall, 87 ft.; rake at ends, 7 ft.; depth including bottom planking, 8 ft.; load draught, 4 ft. 2 in. Electric welding unit is to consist of two 400-ampere constant-potential arc-welding General Electric sets.

Generator for

A New Type of ArcWelding Generator, S. R. Bergman. Gen. Elec. Rev., vol. 23, no. 5, May, 1920, pp. 442-446, 9 figs. Direct-current machine with dual magnetic circuits.

Machinery for

Arc Welding Machinery of the U. S. Light & Heat Corporation, W. A. Turbayne. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 535-536. Notes on single-circuit type of arc welding machinery.

Characteristics and Performance of Arc Welding Machinery, A. M. Candy. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 531-533, 5 figs. Discusses increased efficiency of constant-potential welding circuit and decreased size and cost of apparatus by changing generated circuit potential from 75 to 60 volts, and gives curves showing efficiency increase and also disadvantages attending any material decrease of circuit potential below 60 volts.

ELECTRICAL APPARATUS

Cost Reduction

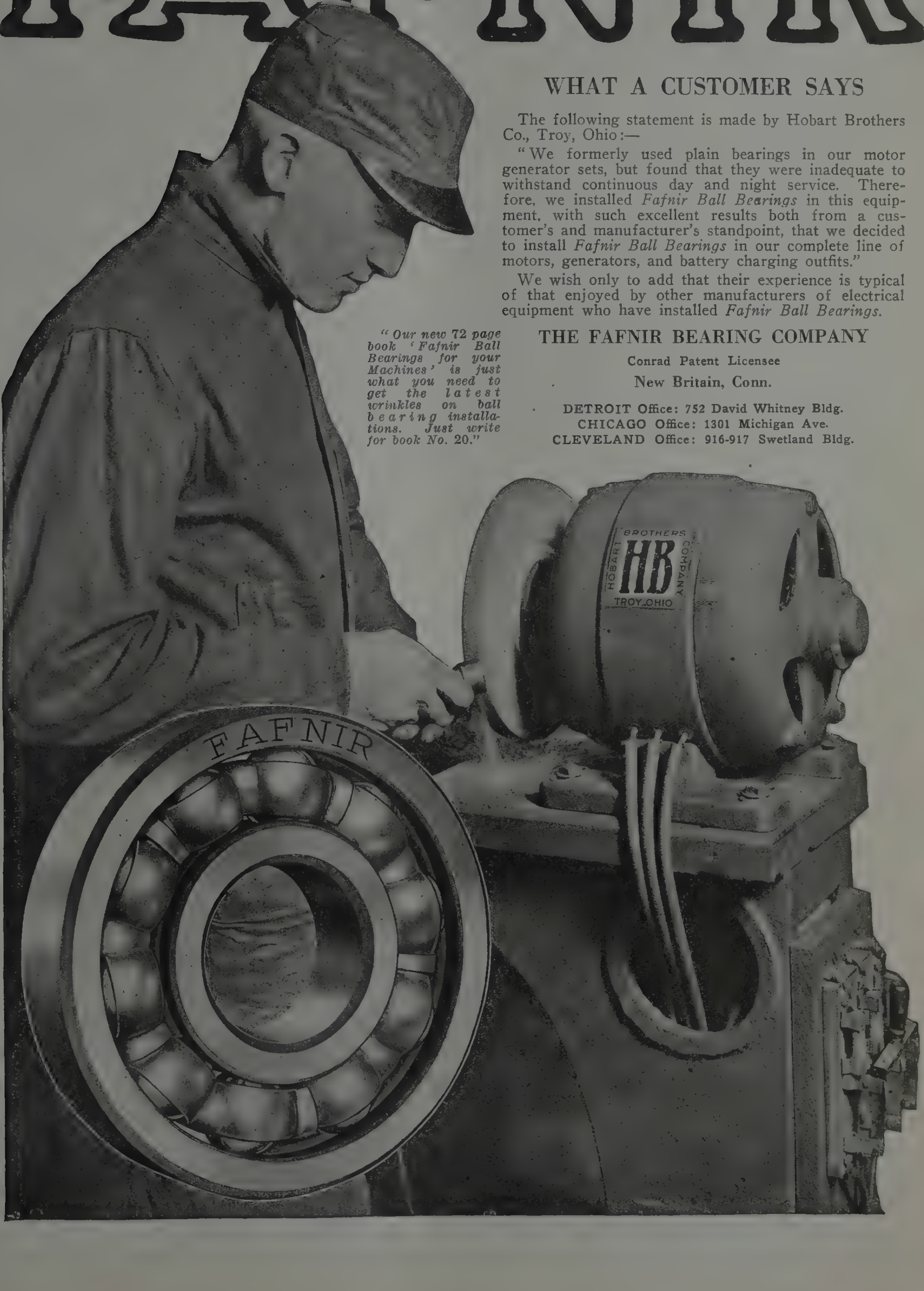
Present Status of Electrical Apparatus. Elec. World, vol. 75, no. 22, May 29, 1920, pp. 1261-1264, 4 figs. Standardization of electrical apparatus is suggested as best means of bringing down high cost of equipment. Committee report presented at convention of Nat. Elec. Light Assn.

ELECTRICAL MACHINERY

Carbon and Commutator Wear

Carbon and Commutator Wear, R. E. Hellmund. Jl. Am. Inst. Elec. Engrs., vol. 39, no 6, June, 1920, pp. 579-582, 7 figs. Account of tests performed by writer.

FAFNIR



WHAT A CUSTOMER SAYS

The following statement is made by Hobart Brothers Co., Troy, Ohio:—

"We formerly used plain bearings in our motor generator sets, but found that they were inadequate to withstand continuous day and night service. Therefore, we installed *Fafnir Ball Bearings* in this equipment, with such excellent results both from a customer's and manufacturer's standpoint, that we decided to install *Fafnir Ball Bearings* in our complete line of motors, generators, and battery charging outfits."

We wish only to add that their experience is typical of that enjoyed by other manufacturers of electrical equipment who have installed *Fafnir Ball Bearings.*

"Our new 72 page book 'Fafnir Ball Bearings for your Machines' is just what you need to get the latest wrinkles on ball bearing installations. Just write for book No. 20."

THE FAFNIR BEARING COMPANY

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CLEVELAND Office: 916-917 Swetland Bldg.

ENGINEERING INDEX (Continued)

Eddy Currents in Stator Windings

Eddy Currents in Stator Windings, H. W. Taylor. Jl. Instn. Elec. Engrs., vol. 58, no. 290, Apr., 1920, pp. 279,298 and (discussion) pp. 298-300, 23 figs. Formulæ are developed for calculating eddy currents losses in conductors, both at bottom in slot and higher than bottom, and in top conductors when subjected to external influence of currents out of phase with those they themselves carry; also losses in conductors consisting of a number of laminations connected solidly together at ends, and in coils in which insulated laminations are continued from turn to turn, as well as in conductors and coils in which insulated laminations successively occupy different positions in conductor.

Magnetic Flux

A Direct Recording Method of Measuring Magnetic Flux Distribution, F. S. Dellenbaugh, Jr. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 583-587, 2 figs. Revolving search coil fitted with collecting device and operating at high and constant speed.

Pole-Face Leakage

A Theory of Pole-Face Leakage (Eine Theorie der Stirnstreuung), Ludwig Dreyfus. Elektrotechnische Zeitschrift, vol. 41, nos. 6 and 7, Feb. 5 and 12, 1920, pp. 106-111 and 128-132, 21 figs. Writer seeks to overcome difficulties which stand in way of the space determination of the pole-face stray field. A theory of leakage from a single pole face is developed and results compared with those of other authors. Calculation of reciprocal inductance between coil ends of the same and of different phases are given with aid of tables.

Speed Regulation

New Devices for maintaining Speed of Electric Machines Constant (Neuere Einrichtungen zum Konstanthalten der Drehzahl elektrischer Maschinen), Elektrotechnischer Anzeiger, vol. 36, nos. 144 and 145, Dec. 9 and 10, 1919, pp. 689-690 and 693-694, 11 figs. Details and illustrations of various devices recently patented.

ELECTROLYSIS

See CORROSION.

ELECTROMAGNETISM

Kinematic Interpretation

A Kinematical Interpretation of Electromagnetism, Leigh Page. Proc. Nat. Acad. of Sciences, vol. 6, no. 3, March 1920, pp. 115-122, 4 figs. Equations of electrodynamics are shown to be simple kinematical relations between moving elements which constitute lines of force. If sources of these moving elements are supposed to rotate, free magnetic charges are produced and four equations of electromagnetic field assume symmetrical form. Energy radiated due to rotation is found to amount almost exactly to 1/32 hv for each revolution.

ELEVATORS

Inspection

What Constitutes Proper Elevator Inspection, D. J. Gitto. Safety Eng., vol. 39, no. 4, Apr., 1920, pp. 189-191. Instruction for the inspection of machines, overhead, shaft and car. Writer believes that a car should never be operated and inspected by one and the same person. From Proc. of Am. Soc. of Safety Engrs.

Mechanical Interlocks

Mechanical Elevator Interlocks, Clayton W. Old. Safety Eng., vol. 39, no. 5, May 1920, pp. 243-251, 3 figs. Study of elevator shaft door accidents, their causes and current means of prevention. From Proc. of Am. Soc. of Safety Engrs.

Ropes

Reserve Strength of Elevator Ropes, W. Voigtlander. Safety Eng., vol. 39, no. 4, Apr. 1920, pp. 194-197, 7 figs. Gives results of tests of 6 × 19 ropes showing reserve strength, and illustrates method of socketing wire rope. From Proc. of Am. Soc. of Safety Engrs.

EMPLOYEES' REPRESENTATION

Standard Oil Company

Employee Representation on the Job in Standard Oil. Burton Kline. Indus. Management, vol. 59, no. 6, June 1920, pp. 496-501. Experience of Standard Oil Co. during past two years in which conferences between employee representatives and officers have been held periodically at refineries and oil fields.

Trend of

Trends in Management, William Leavitt Stoddard. Factory, vol. 24, no. 9, May 15, 1920, pp. 1544-1546, 7 figs. Gives charts from which, it is said, progress in employee representation movement may be studied profitably.

ENGINEHOUSES

Standard Designs

A Unit Construction Method for Engine Houses. Ry. Age, vol. 65, no. 24, June 11, 1920, pp. 1663-1667, 6 figs. Standard designs developed by Pennsylvania system.

EXCAVATING MACHINES

German

Excavating Machines in Lignite Surface Mines (Grabenbagger in Braunkohlentagebaubetrieben). Braunkohle, vol. 18, nos. 41 and 42, Jan. 10 and 17, 1920, pp. 527-533 and 545-548, 22 figs. Machines constructed by the firms of Orenstein & Koppel, Berlin, and the Lübeck Machine Construction Co., Lübeck, with and without ramp cutters, consisting of bucket elevator excavator mounted on caterpillar tractor and provided with belt conveyors discharging at each side of machine.

EXPLOSIVES

Tests

Theoretical Maximum Pressure Developed in Own Volume by Thirteen Military Explosives, J. E. Crawshaw. Jl. of Franklin Inst., vol. 189, no. 5, May 1920, pp. 607-625. Results of tests performed at Explosives Experiment Station of Bur. of Mines.

TNT

TNT as a Blasting Explosive, Charles E. Munroe and Spencer P. Howell. U. S. Dept. of Agriculture, Dept. Circular no. 94, May 1920, 24 pp., 12 figs. Results of investigations conducted at U. S. Bur. of Mines to discover safest and best ways of utilizing TNT for industrial blasting purposes. Physical and chemical properties of different grades of explosives are given, together with precautions to be observed in handling, packing, preparation of cartridges, and charging, and results of field tests in blasting stumps, rocks and other work are presented and compared with similar results obtained from dynamite.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FERROALLOYS

Properties

Variations of Magnetic Properties, Resistivity and Density of Ferroalloys with Their Chemical Composition and Thermal Treatment (Variations des propriétés magnétiques, de la résistivité et de la densité des alliages de fer avec leur composition chemique et leur traitement thermique), E. Gumlich. Revue générale de l'Électricité, vol. 7, no. 18, May 1, 1920, pp. 581-588, 10 figs. Researches undertaken at laboratory of technical university of Aix-la-Chapelle and at various foundries. Studies were made with electrolytic iron, ferrocarbon, ferrosilicon, ferroaluminum and ferromanganese. Translated from Electrotechnische Zeitschrift, vol. 40, June 26, July 3, 10, 17 and 24, 1919, pp. 312-324, 334, 350 and 361, 21 figs.

[See also TITANIUM.]

FLIGHT

Physics of

The Physics of Flight, David L. Webster. Jl. of Franklin Inst., vol. 189, no. 5, May 1920, pp. 553-580, 8 figs. Laws of aerodynamics are stated and their application to flight of aeroplanes discussed.

FLOATING DOCKS

Design

The Design of Floating Docks. Public Works of the Navy. Under the Cognizance of the Bureau of Yards and Docks and the Corps of Civil Engineers, U. S. Navy, Bul, no. 31, Apr. 1920, pp. 47-83, 12 figs. Maximum moments are calculated for bulkhead, cross-girders, and side walls. Structure considered consists of single side walls connected by girders which are in turn connected by continuous main bulkhead. Translation of two articles, one published in Zeitschrift für Bauwesen in 1892, and another in Schiffbau of May 8, 1912, latter being amplification and generalization of method outlined in former article.

FLOORS

Reinforced-Concrete

Charts Giving Thickness and Reinforcement of Reinforced-Concrete Floor Slabs (Diagrammes donnant les épaisseurs et les reforcements des dalles de hourdis en béton armé), Henri Kampmann. Génie Civil, vol. 76, no. 13, March 27, 1920, pp. 312-314, 3 figs. One chart gives thickness for slab of known length required to support known load, and another the reinforcement required for slab.

FLOTATION

Adsorption Conditions

Flotation from the Standpoint of Colloidal Chemistry (Die Schwimmaufbereitung vom Standpunkt der Kolloidchemie), P. Vageler. Metall u. Erz, vol. 17, no. 5, Mar. 8, 1920, pp. 113-119. Writer maintains that as a purely qualitative method of investigation the flotation method is the most unsuitable; but recommends as promising genuine success in regard to the whole problem, a quantitative, systematic study of the absorption conditions in three-phase and multi-phase systems of the most important ores in connection with the technical reagents. Address delivered before Soc. of German Met. & Min. Engrs.

Machines

A New Flotation Machine, A. W. Fahrenwald. Pahasapa Quarterly, vol. 9, no. 3, April 1920, pp. 125-130. Pneumatic machine designed without porous bottoms.

FLOW OF FLUIDS

Laws

The Laws of Elastico-Viscous Flow—II. Jl. Geology, vol. 28, no. 1, Jan.-Feb. 1920, pp. 18-24. Concerning combination of laws of Larmor and of Maxwell proposed by Harold Jeffreys (see monthly notices of Royal Astronomical Soc., vol. 77, no. 5). First article appeared in Jl. Geology, vol. 25, 1917, pp. 405-410.

FLOW OF WATER

Reservoirs

Equilibrium of Water Flowing Into Reservoir (Sur le régime permanent dans les chambres d'eau), M. C. Camichel. Comptes rendus des Séances de l'Académie des Science, vol. 170, no. 17, April 26, 1920, pp. 986-988. General formulæ giving distribution of velocities in liquid mass according to three rectangular axes.

FLYING BOATS

Hulls

Flying Boats—The Form and Dimensions of Their Hull, G. S. Baker. Eng., vol. 109, no. 2827, Mar. 5, 1920, pp. 323-327, 6 figs. Dynamics requirements of hull are considered under the several headings of diving at low speed, seaworthiness, and ability to change trim at high speeds. Comparison is made between results obtained in full-scale tests and of similar results deduced from tank experiments.

Notes on Flying Boat Hulls, Linton Hope. Flight, vol. 12, nos. 21, 22 and 23, May 20, 27, and June 3, 1920, pp. 546-548, 5 figs, 569-573, 9 figs., and 590-593, 5 figs. Also Aeronautics, vol. 18, no. 344, May 20, 1920, pp. 396-399. Paper read before Royal Aeronautical Society. Deals with method of designing flying-boat hulls and with estimation of weights and proportions.

FOREMEN

Place in Industrial Progress

The Foreman's Place in Industrial Progress. Eng. & Indus. Management, vol. 3, no. 18, Apr. 29, 1920, pp. 557-559. Deals with importance of foreman's part in industrial progresss as "link" between manager and workers.

FOUNDATIONS

Footings

Flat Foundations—Concrete, Reinforced Concrete, Masonry, etc. [Étude sur les fondations par empattements (Béton, béton-armé, maçonneries, etc.)], Aimé Willame and Henri Chenu. Annales des Travaux publics de Belgique, vol. 21, no. 2, Feb. 1920, pp. 7-81, 26 figs. Mathematical study of stresses. Stresses developed at bottom of massive base are computed approximately from theory of flexure.

[See also MACHINERY.]

FOUNDRIES

Equipment

Old Firm Erects Modern Foundry. Foundry, vol. 48, no. 12, June 15, 1920, pp. 461-466, 11 figs. Equipment of foundry in Ohio in which a wide and varied line of punches, shears and other machinery employed in fabricating plates and shapes, is produced.

Steel, for Automobile Castings

A Modern Steel Foundry. Automobile Engr., vol. 10, no. 138, May 1920, pp. 186-189, 15 figs. Description of foundry at Bilston, Staffordshire, England, which specializes in manufacture of automobile castings.

FUELS

[See LIGNITE; PULVERIZED COAL.]

FURNACES, ELECTRIC

[See ELECTRIC FURNACES.]

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ENGINEERING INDEX (Continued)

FURNACES, ROASTING

Cottrell Treater

Tooele Flue-Type Cottrell Treater, A. B. Young. Min. & Metallurgy, no. 162, June 1920, pp. 31-32, 1 fig. Apparatus installed at plant of International Smelting Co. for recovery of solids from gases from McDougall roasting furnaces. It consists of flue containing rows of vertical plates forming grounded electrode, alternated with rows of small horizontal pipes forming negative electrode, with proper provision underneath for taking away collected dust.

FURNACES, METALLURGICAL

Chantraine

Chantraine Polymultiple Flame Metallurgical Furnace (Fours métallurgiques a flammes polymultiples système Chantraine). Génie Civil, vol. 76, no. 14, April 3, 1920, pp. 336-337, 2 figs. Jet of air is blown into atmosphere of combustible gas, instead of gas flowing into air. Greater intensity of heat and perfect combustion are claimed as advantages.

G

GAGES

Stellite for

Stellite, a New Gage Material, H. L. Van Keureen. Am. Mach., vol. 52, no. 20, May 13, 1920, pp. 1045-1047. Results of investigations made demonstrate, it is claimed, that stellite is well suited for precision-gage reference standards of the better quality. It is believed that such a gage would be economical where it is necessary to use a reference gage at very frequent intervals or perhaps continuously.

Vertical Projection Apparatus

Vertical Gauge Projecting Apparatus; National Physical Laboratory. Eng., 109, no. 2826, Feb. 27, 1920, pp. 273-276, 14 figs. Standard type designed in National Physical Laboratory, England, Nov. 1917.

GARAGES

[See ARCHES, Reinforced-Concrete.]

GAS

Industrial Fuel

Gas in Relation to Increased Output and National Economy, H. M. Thornton. Jl. Royal Soc. Arts, vol. 68, no. 3517, Apr. 16, 1920, pp. 346-365, and (discussion) pp. 365-366, 17 figs. Notes on the application of gas to peace-time conditions, and contribution it has to offer to difficult problem of production confronting manufacturers. Writer gives examples of increased output as result of gas installation.

Preventable Fuel Loss in High Temperature Heating, Arthur L. Stevens. Combustion, vol. 2, no. 5, May 1920, pp. 24-26, 1 fig. Writer maintains the installation of gas apparatus and its application to industrial heating demands experience not found in average plant, and that in order to effect greatest saving in fuel consumption in industrial plants, it is necessary to make use of a higher class of equipment both as to apparatus and operatives. Gives an example of saving in a recent installation.

GAS ENGINES

Small, Manufacture of

Machining the Gas Engine for a Lighting Unit—II, J. V. Hunter. Am. Mach., vol. 52, no. 19, May 6, 1920, pp. 995-998, 12 figs. Miscellaneous operations in connection with manufacture of gas engine for small self-contained lighting unit.

GAS LIGHTING

See LIGHTING, Street.

GAS MANUFACTURE

See WATER GAS.

GAS MASKS

Active Charcoal for

The Heat of Absorption of Vapors on Charcoal, Arthur B. Lamb and A. Sprague Coolidge. Jl. Am. Chem. Soc., vol. 42, no. 6, June 1920, pp. 1146-1170, 9 figs. Measurements of heat of absorption of 11 organic liquids upon charcoal at 0 deg. cent. Values were found to be independent of rate of absorption of vapor and previous history of charcoal.

GAS METERS

Electric

The Thomas Electric Gas Meter, Ralph H. Earle. Armour Engr., vol. 11, no. 3, March 1920, pp. 181-194, 14 figs. Designed for measurement of gas in large quantities. Gas is warmed exactly 2 deg. by means of electric heater. Measure of electrical energy required by heater is measure of gas flowing.

GAS WARFARE

German Gases

Gas Warfare in the European War of 1915 to 1918 (Les gaz de combat, et leur emploi dans la guerre européenne, de 1915 a 1918), Daniel Florentin. Génie Civil, vol. 76, no. 18, May 1, 1920, pp. 409-411. Gases used by the Germans. (To be continued.)

Projectiles

Gas Warfare in the European War of 1915 to 1918 (Les gaz de combat, et leur emploi dans la guerre européenne, de 1915 à 1918), Daniel Florentin. Génie Civil, vol. 76, no. 19, May 8, 1920, pp. 427-432, 11 figs. Gas projectiles used. (Concluded.)

GASES

Entropy of

The Entropy of Gases, Richard C. Tolman. Jl. Am. Chem. Soc., vol. 42, no. 6, June 1920, pp. 1185-1193. Comparison of experimental results of entropy at one atmosphere and 298 deg. absolute and values determined theoretically from formula.

Flow in Pipes

The Hot-wire Anemometer: Its Application to the Investigation of the Velocity of Gases in Pipes, J. S. G. Thomas. Lond., Edinburgh & Dublin Phil. Mag. & Jl. of Science, vol. 39, no. 233, May, 1920, pp. 505-534, 18 figs. partly on 4 supp. plates. Experiments carried out at Physical Laboratory of South Metropolitan Gas Co.

Liquefied

Electric Energy of Escaping Liquid—A Possible Medium for the Improvement of Gas Liquefaction (Elektrische Arbeit ausströmender Flüssigkeit—Ein Mittel zur Verbesserung der Gasverflüssigung?), Walther Meissner. Berichte der deutschen physikalischen Gesellschaft, vol. 21, no. 11-12, June 30, 1919, pp. 369-382, 6 figs. Describes a new method for transforming the kinetic energy of the escaping jet inside of liquefier into potential electric energy which can then be easily conducted from liquefier by means of fine wires; and a method for electrification of liquid hydrogen and helium. Report from the Nat. Physical-Technical Inst.

Investigation of Basic Principles of Construction of Containers for the Transportation of Liquefied Gases (Untersuchungen über die Grundlagen zum Bau von Transportgefässen für verflüssigte Gase), Fritz Banneitz, Gerhard Rhein and Benno Kurze. Annalen der Physik, vol. 61, no. 2, Jan. 15, 1920, pp. 113-144, 8 figs. Investigations are said to show that it is possible even with sheet-steel containers to produce the high vacuum required for the storage of liquefied gases, if the brazing is carefully carried out which, it is said, is best effected with silver solder. The insulation of the neck of a small container can be effected, according to Lilienfeld, by inserting a short glass tube which is joined at both ends to the metal by means of platinum ring joints, while for large containers sufficiently long metal tubes of low conductivity should be used. Report from Physical Inst. of University of Leipzig.

GASOLINE

Natural-Gas

A Great Natural Gas Industry, Oswald F. Schuette. Gas Age, vol. 45, no. 9, May 10, 1920, pp. 392-395, Compilation of facts and figures relating to natural-gas gasoline, demonstrating importance of gas as sources of supply.

Gasoline from Natural Gas, C. E. Reese. Gas Age, vol. 45, no. 9, May 10, 1920, pp. 382-384, 2 figs. Details of gasoline absorption plant with plan of piping.

Situation in the United States

The Motor Gasoline Situation, N. A. C. Smith. Oil News, vol. 8, no. 9, April 5, 1920, pp. 32-34. It is said that automotive vehicle demand for gasoline has increased in ten years 17 times more than production of crude-oil supplies. From the U. S. Bureau of Mines, Reports of Investigations.

GASOLINE ENGINES

Aluminum Pistons

Machining Aluminum Pistons, P. T. Lennon. Am. Mach., vol. 52, no. 23, June 3, 1920, pp. 1175-1176, 3 figs. Tools used.

Single-Cylinder, Manufacture of

The Manufacture of Single-Cylinder Gasoline Engines, J. V. Hunter. Am. Mach., vol. 52, nos. 21 and 24, May 20 and June 10, 1920, pp. 1079-1083, 15 figs. and 1237-1239, 10 figs. Practice of Filler & Johnson Manufacturing Co., Madison, Wis. Special boring-mill tools for turning flywheels, and methods of grinding valves.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES.]

GEARS

Testing Machines

Spur and Bevel Gear Testing Machine at the National Physical Laboratory, T. E. Stanton. Eng., vol. 109, no. 2828, March. 12, 1920, pp. 334-335, 7 figs. Also describes Daimler-Lanchester worm-gear testing machine for direct measurement of ratio of torques of driving and driven shafts.

GLASS

Ampuls

The Selection of Glass for the Manufacture of Ampuls, George E. Ewe. Jl. of Franklin Inst., vol. 189, no. 5, May, 1920, pp. 649-653. Tests are suggested.

GOLD METALLURGY

Amalgamation

Can Amalgamation be Dispensed With? E. M. Weston. Jl. Chem. Metallurgical & Min. Soc. of South Africa, vol. 20, no. 8, Feb., 1920, pp. 131-139, 2 figs. How to eliminate amalgamation in metallurgy of gold and silver ores.

Means Adopted on the New Goch Gold Mine for Reducing the Consumption of Mercury, H. J. Lee. Jl. Chem. Metallurgical & Min. Soc. or South Africa, vol. 20, no. 8, Feb., 1920, pp. 139-141. Amalgamation is carried out with 12 plates in tube-mill house. Loss of mercury is said to be reduced by decreasing number of dressings without any loss in actual recovery

Gold Field

The Limits of Payable Yield of Fine Gold per Ton of Ore with Premiums & Prices of Gold and Working Costs as Shown, W. A. Caldecott. Supp. to Jl. Chem. Metallurgical & Min. Soc. of South Africa, vol. 20, no. 8, Feb., 1920, chart facing, p. 147. Prices of fine gold are calculated by assuming mint par has equivalent to 77/9 per standard oz. (11/12 fine.)

GRAVITATION

Researches in

On Gravitation. Theoretical and Experimental Researches, Q. Majorana. Lond., Edinburgh & Dublin Phil. Mag. & Jl. of Science, vol. 39, no. 233, May, 1920, pp. 488-504, 4 figs. Examining Newton's law writer concludes that force of gravitation can weaken itself by absorption due to ponderable matter. He visualizes possibilities that matter which shows force of gravitation might heat itself. Method is theoretically determined for estimating density from "factor of gravitational absorption" of a body. In this manner density of sun is computed to be 4.27.

GRINDING

Modern Methods

Grinding Practice in Production—II, H. Darbyshire. Eng. Production, vol 1, no. 6, June, 1920, pp. 213-216, 5 figs. Early experiences and latter day methods.

GRINDING MACHINES

Crankpin

The Landis Crank Grinder. Eng. Production, vol. 1, no. 5, May, 1920, pp. 195-196, 3 figs. Production of Landis Tool Co. of Waynesboro, Pa. Crank heads are designed and necessary features added to make machine adaptable for grinding of crank pins.

GUN MOUNTS

Recoil Mechanism

Unusual Methods of Securing Extreme Accuracy—III and IV, A. L. De Leeuw. Am. Mach., vol. 52, nos. 20 and 21, May 13 and 20, 1920, pp. 1049-1053, 17 figs. and 1094-1097, 8 figs. Work involved in machining recoil mechanism for gun carriages.

GUNS

Erosion of

See STEEL, Nitrogen in.

Schneider 155-Mm.

The Schneider 155-MM. Gun. Eng., vol. 109. no. 2833, Apr. 16, 1920, pp. 512-513, 7 figs. Principal data: Total length of gun, 16 ft. 3 in.; length of gun in firing position, 26 ft. 11 in.; weight of gun complete, 8307 lb.; weight of gun in firing position, 19,320 lb.; wheel tracks, carriage, 6 ft. 1⅝ in.; wheel track, gun carrier, 6 ft. 5 11/16 in.

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ENGINEERING INDEX (Continued)

H

HAND LEVERS

Design of

The Design of Forged Hand-Levers, John S. Watts. Machy. (N. Y.), vol. 26, no. 9, May, 1920, p. 855, 1 fig. Includes chart giving dimensions of hand-levers, in which a pull of 150 lb. on handle is provided for.

HANGARS

Modern Designs

Modern Designs of Hangars for Dirigibles (Neuere Systeme von Luftschiffhallen), W. L. Audrée Eisenbau, vol. 11, no. 1, Jan. 13, 1920, pp. 18-38, 50 figs. It is indicated that in order to provide protection of ship against storms as well as safe entrance and exit, the longitudinal axis of hangar should correspond, if possible, to general direction of wind. Details of various designs of stationary and portable hangars. Article was written in 1915, but was not released for publication until after the war.

HARDNESS

Ball Test

Note on "The Ball Test," Thomas Baker Iron & Steel Inst., Paper 2, Annual Meeting, May 6 & 7, 1920, 16 pp., 9 figs. Experiments conducted to ascertain significance of constants a and n, b and m in relations $L=bVm$ and $L=adn$, and to correlate variations in them with changes in other physical properties of material under investigation.

Brinell High-Temperature Testing Machines

Brinell Machine for High-Temperature Testing. Eng., vol. 109, no. 2822, Jan. 30, 1920, p. 157, 3 figs. Specimens of steel wire tested at different temperatures up to 850 deg. cen. Hardness curves constructed show that the greater the cutting efficiency the higher is the Brinell hardness at elevated temperatures.

HEALTH

See HEATING AND VENTILATION, Health and Humidity.

HEAT

Conduction of

Bromwich's Method of Solving Problems in the Conduction of Heat, H. S. Carslaw. Lond., Edinburgh & Dublin Mag. & Jl. of Science, vol. 39, no. 233, May, 1920, pp. 603-611, 3 figs. In a paper edited in Philosophical Magazine, 220, April, 1919, Bromwich advocated use of so-called operational methods in electrical and other physical problems. Modifications in application of such suggestion are proposed.

Oxidized Alcohol as Source

On the Nature of the Heat Production in a System of Platinum Black, Alcohol, and Air, L. B. Loeb. Proc. Nat. Acad. of Sciences, vol. 6, no. 3, March, 1920, pp. 107-110. It is concluded from experiments that heat is liberated principally in process of oxidation of alcohol on surface of platinum and only to a small extent by adsorption of air or alcohol vapor by platinum black.

HEAT LOSSES

Pipes Buried in Ground

Theory of Heat Losses from Pipes Buried in the Ground, John R. Allen. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May, 1920, pp. 455-469, 10 figs. It is concluded from experiments in Research Bureau at U. S. Bur. of Mines Laboratories, (1) that heat loss from pipe is not proportional to external surface of pipe, (2) that heat loss per linear foot of pipe becomes smaller as pipe diameter increases, (3) that heat loss from pipe is not proportional to thickness of covering and that there is very little advantage to be gained in increasing thickness of insulation to more than two inches, (4) that depth to which covered pipe is buried makes very little difference in heat loss, provided center of pipe is 2 ft. or more below ground surface, (5) that heat loss from pipe is not proportional to conductivity of covering, and (6) that poor covering in dry ground will give better results than good covering in wet ground.

Steam Pipes

Heat Insulation Facts, L. B. McMillan. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May, 1920, pp. 387-402, 7 figs. Curves showing rates of heat losses from uninsulated surfaces, chart indicating heat lost by bare steam pipe and saving which may be secured by using good covering, graph of variation of heat transmission for various thicknesses of material on flat surfaces, etc.

HEAT TREATING

Plant Layouts

Heat Treating Plant for Traction Parts, Edmund Blasko. Am. Drop Forger, vol. 6, no. 5, May 1920, pp. 222-227, 4 figs. Notes on layout and management.

Layout of Heat Treating Plant for Tools, John J. Jones. Am. Drop Forger, vol. 6, no. 5, May 1920, pp. 228-229, 2 figs. Suggestions in regard to layout, construction and operation.

Plants

General Industrial Heat Treating Plant, William J. Merton. Am. Drop Forger, vol. 6, no. 5, May 1920, pp. 216-221, 5 figs. Analysis of factors to consider in plant.

[See also ELECTRIC FURNACES, Heat-Treating.]

HEATING AND VENTILATION

Air Inlets in Window Sills

Observations of an Auditorium Having Air Inlets in the Window Sills, Samuel R. Lewis. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1920, pp. 415-422, 6 figs. Studies made to determine effect of arrangement of inlets and outlets on distribution of fresh air.

Health and Humidity

Symposium on Health and Humidity, E. Vernon Hill and J. J. Aeberly. Jl. Am. Soc., Heat. & Vent. Engrs., vol. 26, no. 4, May 1920, pp. 471-488, 9 figs. Subjects discussed were relation of death rate to wet-bulb temperature prevailing, and relation of wet-bulb temperature to health.

HEATING

Central-Station

[See HEAT LOSSES, Pipes Buried in Ground.]

HEATING, ELECTRIC

Drying Ovens

Electric Heating in Steel Wire Manufacture. Am. Drop Forger, vol. 6, no. 5, May 1920, pp. 236-238, 2 figs. Comparative cost statistics taken at plant of Halcomb Steel Company on drying ovens heated electrically and similar ovens using coke and steam.

Induction-Type Apparatus

A New Electric Heating and Cooking Apparatus (Ein neuer elektrischer Heiz- und Kochapparat), E. Fr. Russ. Elektrotechnische Zeitschrift, vol. 41. no. 4, Jan. 22, 1920, pp. 74-75, 2 figs. Description of an induction heater.

Industrial

Industrial Electric Heating, Wirt S. Scott. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1920, pp. 431-440, 7 figs. Advantages claimed are cleanliness, absence of objectionable gases and of products of combustion, elimination of fire hazard, ease of operation, economy and automatic maintenance of temperature.

HELIUM

U. S. Plant, Fort Worth, Tex.

United States Helium-Production Plant, Fort Worth, Tex., Willard A. Pollard. Public Works of the Navy, Under the Cognizance of the Bureau of Yards and Docks and the Corps of Civil Engineers, U. S. Navy, Bul. no. 31, Apr. 1920, pp. 13-46. 10 figs. Helium is extracted from natural gas by compression of incoming gas to high pressure, removal of heat of compression by circulation of cold water, progressive cooling resulting from expansion of highly compressed gas through expansion value to low pressure, and application of cold waste gases and closed external refrigerating cycles of nitrogen and CO_2 as refrigerating media. Capacity of plant is 40,000 cu. ft. of helium per day.

HOT-WATER SUPPLY

Piping, Rust Prevention in

The Prevention of the Red-Water Plague, Wm. H. Walker. New England Water Works Assn., vol. 34, no. 1, March 1920, pp. 33-38 and (discussion) pp. 38-48, 6 figs. System for deactivation of water which has been installed in large apartment house in New York City.

HOUSES, CONCRETE

Block and Tile

Concrete Block and Tile House Construction. Contract Rec., vol. 34, no. 19, May 12, 1920, pp. 441-443. Code of recommended practices for concrete block and tile house construction reported by special committee to Nat. Conference on Concrete House Construction.

Recommended Practice for Block and Tile House Construction. Concrete Products, vol. 18, no. 5. May 1920, pp. 19-21, 1 fig. Report of Sub-Committee A of Nat. Conference on Concrete House Construction.

Rapid Construction

Comfortable and Permanent Industrial Homes of Concrete. Compressed Air. Mag., vol. 25, no. 5, May 1920, pp. 9649-9650, 2 figs. Industrial housing project sponsored by Ingersoll-Rand Co. of New York for its factory employees at Phillipsburg, N. J.

HOUSING

Eliminating Slums

Eliminating the Slums, Emile G. Perrot. Jl. Engrs. Club of Philadelphia, vol. 37-6, no. 187, June 1920, pp. 235-241, 15 figs. Danger of unfit housing is pointed out as well as economic advantages resulting from erecting sanitary industrial houses. Typical models in industrial villages in England and United States are illustrated.

Industrial

The Financial Problems of Industrial Housing, Leslie H. Allen. Mech. Eng., vol. 42, no. 6, June 1920, pp. 346-348. Housing shortage is said to be due partly to fear of financial panic and partly to fact that, high as rents are, they are not high enough to show adequate return on present-day construction costs. Relation of rents to capital invested, calculation of proper rents, and methods of financing house construction are discussed. A scheme of co-operative housing is suggested as solution of present housing problems.

Your Housing Problem. Factory, vol. 24, no. 8, May 1, 1920, pp. 1317-1323, 10 figs. Ideas for meeting it, drawn from an investigation among 1,000 industrial concerns.

[See also HOUSES, CONCRETE, Rapid Construction.]

HOWITZERS

Schneider 155-Mm.

The Schneider 155-MM. Howitzer. Eng., vol. 109, no. 2831, Apr. 2, 1920, pp. 442-443, 5 figs. Particulars: Wheel track, 5 ft.; diameter of wheels, 4 ft. 4½ in.; total length of gun team with pole, 32 ft. 11 in.; weight, complete in firing position, 7273 lb. (To be continued.)

HUMIDITY

See HEATING AND VENTILATION.

HYDRAULIC TURBINES

Bauersfeld Blading

Experiments on a Turbine Runner with Bauersfeld Blading. (Versuche an einem Turbinen-Laugrad mit Bauersfeld-Schaufelung), Ernst Reichel. Zeitschrdift für das gesamte Turbinenwesen, vol. 16, nos. 33, 34 and 35, Nov. 30, Dec. 10 and 20, 1919, pp. 353-356, 369-372 and 377-379, 14 figs. Description and results of experiments with a turbine having blades constructed according to design of Dr. Bauersfeld, in which, it is said, main current flows free of eddies.

Wear

Wear of Hydraulic Turbines, Its Consequences and the Means of Reducing It (L'usure des turbines hydrauliques, ses conséquences et les moyens d'y parer), Henry Dufour. Bulletin technique de la Suisse romande, vol. 46, no. 9, May 1, 1920, pp. 97-100, 3 figs. Sand-settling basin in hydroelectric plant at Ackersand (Vallais). (Continuation of serial.)

HYDROELECTRIC PLANTS

France

The Hydroelectric Plant at Vernes, near Livet, Isère, France (L'usine hydro-électrique des Vernes, a Livet (Isère)), Auguste Pawlowski. Génie Civil, vol. 76, no. 15, Apr. 10, 1920, pp. 345-349, 9 figs. Plant comprises two turbines, each operating a single-phase 5000-volt 3000-kva alternator at speed of 375 r.p.m.

Ontario, Can.

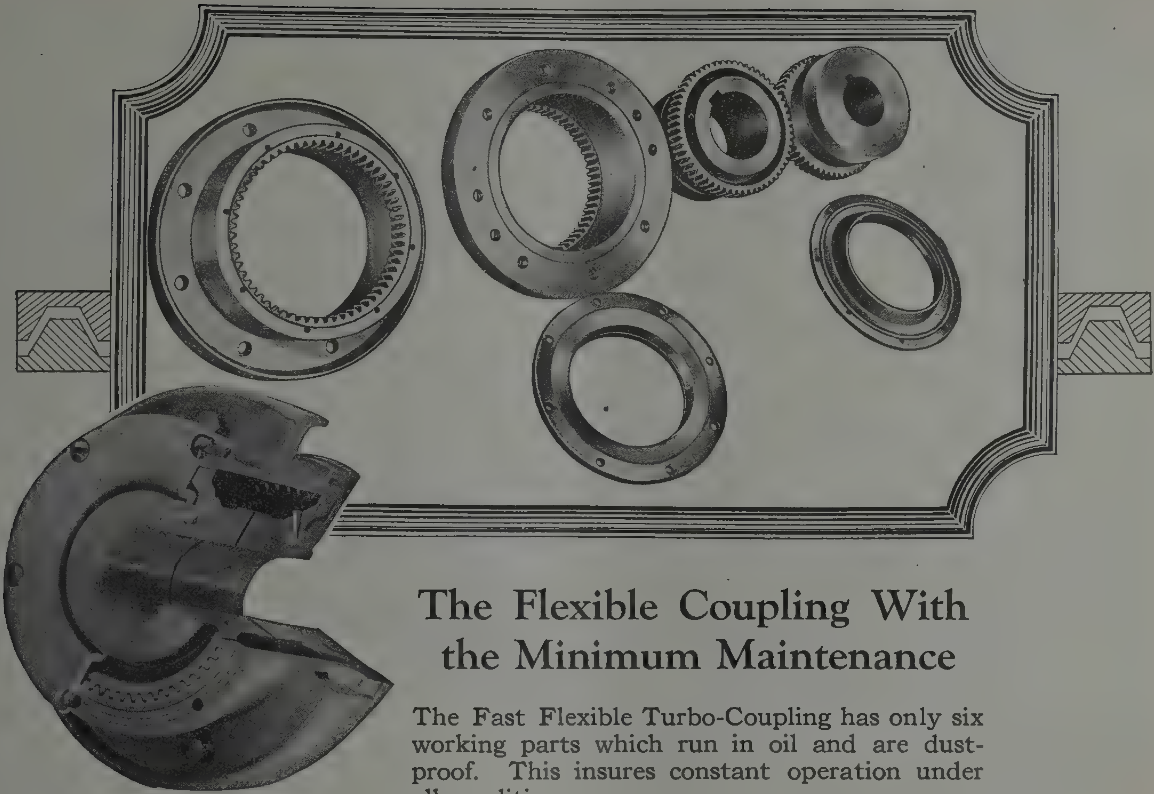
The Central Ontario System of Hydro-Electric Power, G. B. Smith. Jl. Eng. Inst. of Canada, vol. 3, no. 6, June 1920, pp. 289-292, 1 fig. System comprises seven power houses operating in parallel and feeding into a system of 370 miles of 44,000-volt transmission lines.

Semi-Portable Machine Shelters

An Alternative for Outdoor Generators, Henry G. Reist. Gen. Elec. Rev., vol. 23, no. 5, May 1920, pp. 360-361. Reference is made to article on Outdoor Generators published in Gen. Elec. Rev., March 1920. It is suggested that in order to overcome difficulties there envisaged arising from sluggishness developed by lubricating oils in cold weather, standard generators be used and housed under inexpensive semi-portable shelters.

Switzerland

The Water Power Plant "Gosgen" on the Aare River (Die Wasserkraftanlage "Gosgen"



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FAST FLEXIBLE TURBO-COUPLING

an der Aare). Schweizerische Bauzeitung, vol. 75, nos. 17, 18 and 19, Apr. 24, May 1 and 8, 1920, pp. 188-190, 199-201 and 209-210, 24 figs. Construction details and illustrations of power house. Notes on building installations and connecting railway lines, including reinforced-concrete bridge over the Aare River. (Continuation of serial.)

I

INDUSTRIAL MANAGEMENT

Bibliography

A List of Bibliographies on Industrial Engineering and Management. Soc. Indus. Engrs., vol. 3, no. 6, May 1920, 23 pp. Compiled by Committee on Research of Society of Industrial Engineers.

Counsel

Why Industry Seeks Competent Counsel, L. V. Estes. Indus. Management, vol. 59, no. 6, June 1920, pp. 475-480. Significance of competent counsel in improvement and progress of industries.

Employees, Contentment of

Making Employees Interested in Their Work, Harry Dexter Kitson. Am. Mach., vol. 52, no. 19, May 6, 1920, pp. 983-985. Psychological principles involved in process of arousing interest of employees.

Group Working

Grouping Workers to Get Best Results, Eugene J. Benge. Factory, vol. 24, no. 8, May 1, 1920, pp. 1332-1333, 3 figs. It is claimed if each workman in a group produces about same as his neighbor, there is likely to be less dissatisfaction and greater total output. Plan is said to be measure of working force's effectiveness.

The Lincoln Motor Production Plan, I. J. Beatty. Factory, vol. 24, nos. 8 and 9, May 1 and 15, 1920, pp. 1328-1332 and 1547-1549, 2 figs. Notes on handling service cards and explaining group working; dispatching assemblies and recording operations.

Machine Records

Keeping Tab on Machines That Loaf, A. B. Burgess. Factory, vol. 24, no. 8, May 1, 1920, p. 1339, 2 figs. Method of showing management at all times number of machines in operation.

Planning

Output Planning, A. Robert Stelling. Elecn., vol. 84, no. 2189, Apr. 30, 1920, pp. 487-491, 4 figs. Writer contends that planning is a factor in the elimination of waste and should be considered as much a separate function of management as cost accounting and treated as such. Notes on the principles of planning with illustrations of "route sheets" for assembly and machine work.

Production Methods

Increasing Production Without a Bonus—II, Fred H. Colvin. Am. Mach., vol. 52, no. 20, May 13, 1920, pp. 1041-1044. Part played in plan of management of White Motor Co. by monthly publication, The White Book, in which, it is said, all questions are freely and frankly discussed.

Installing Gantt Production Methods, Wallace Clark. Indus. Management, vol. 59, no. 6, June 1920, pp. 443-448. System which permits foremen to fill his orders as rapidly as possible and in proper sequence, and to operate every machine when there is work for it to do.

"Limits" and Their Relation to Increased Production, W. Groocock. Eng. & Indus. Management, vol. 3, no. 17, Apr. 22, 1920, pp. 515-517. The question of mass production of individual commodities is said to be intimately associated with principle of utilizing labor-saving machines for production of numerous articles which are at present employing large amount of manual labor. Discussion of problems of organization and machinery for production of such labor-saving machines.

Mass Production, H. W. Allingham. Elecn., vol. 84, no. 2189, Apr. 30, 1920, pp. 478-479, 3 figs. Writer points out difficulties of mass production in engineering and discusses mass production in a gas-fittings factory, the motor-car industry, etc.

Modern Production Methods—III, IV, and V, W. R. Basset. Am. Mach., vol. 52, nos. 19, 21 and 23, May 6 and 20 and June 3, 1920, pp. 1003-1008, 7 figs, 1087-1090, 2 figs., and 1177-1182, 11 figs. Need for systematic stock keeping is pointed out and record forms are illustrated. May 20: Organization of engineering department. June 3: Tool-order forms and follow-up cards.

The Manufacture of Household Appliances, J. V. Hunter. Am. Mach., vol. 52, no. 23, June 3, 1920, pp. 1173-1174, 5 figs. Method employed for quantity production by Hurley Machine Co., Chicago.

See also Group Working.

Routing

Routing Gears and Machine Parts Through the Factory, J. A. Urquhart. Am. Mach., vol. 52, no. 24, June 10, 1920, pp. 1231-1236, 11 figs. Method used at plant of Brown & Sharpe Mfg. Co. Paper read before Am. Gear Manufacturers' Assn.

Shipyards

Industrial Organization Applied to Shipyard Management, Norman Howard. Indus. Management, vol. 59, no. 6, June 1920, pp. 492-495, 6 figs. Work of industrial management section of Emergency Fleet Corporation.

[See also CUTTING METALS; SHIPBUILDING, Production Systems; TIME STUDY.]

INDUSTRIAL RELATIONS

Employers as Leaders of Workingmen

Leadership and Education the Cures for Our Industrial Ills, Dr. Charles E. Eaton. Coal Age, vol. 17, no. 24, June 10, 1920, pp. 1201-1204. Writer believes that employer of workingmen should make himself their actual leader, because, he says, failure to do so makes possible the demagogue and self-seeker.

Open Shop, Arguments for

The Open Shop Needed for Industrial Welfare, G. W. Dyer. Am. Industries, vol. 20, no. 11, June 1920, pp. 31-32. Necessity for open shop is concluded from consideration that efficiency of a strike depends upon maintenance of closed shop, and strike is "a conspiracy on the part of a small minority to throw the whole social organism into jeopardy and thus by terrorism and threats against the innocent, force society to meet its arbitrary demands."

INSURANCE

Industrial

Group Insurance as Employees' Service, Edward E. Rice. Indus. Management, vol. 59, no. 6, June 1920, pp. 449-453. Group disability insurance, group life insurance, and group annuities, are separately described and limitations of each pointed out. A combination of these is suggested as system of protection for industrial workers, in which they and their employers coöperate.

Knowing Your Insurance Policy—II, III and IV, Chesla C. Sherlock. Am. Mach., vol. 52, nos. 20, 21 and 24, May 13, and 20 and June 10, 1920, pp. 1035-1037, 1084-1086, and 1244-1246. Conditions necessary for insurable interest. May 20: Method of payment of premiums, particularly in regard to question of promissory notes. June 10: Effect of representations and warranties or their breach upon contract of insurance.

INSULATORS

Porcelain

Porcelain Insulators (Les isalateurs en porcelaine), O. Boudouard. Revue générale de l'Électricité, vol. 7, no. 21, May 22, 1920, pp. 691-696. Results of chemical analyses of insulators made in England, France, Germany and United States. Report presented to Union of Electrical Syndicates.

Suspension

Factors Controlling the Design and Selection of Suspension Insulators, W. D. A. Peaslee. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June 1920, pp. 571-579, 10 figs. Discussion of factors entering into design and operating behavior of suspension insulators and problems to be solved in designing suspension insulator to overcome objectionable features shown by experience to affect seriously operation of insulators in service. Factors to be taken into consideration in selection of suspension insulators for given condition are given and brief discussion of general trend of future improvements is presented.

INTERNAL-COMBUSTION ENGINES

Manufacture

A Modern Gas & Oil Engine Works. Eng. Production, vol. 1, no. 6, June 1920, pp. 227-231, 16 figs. Organization and methods of Crossley Bros., Ltd., England. Engines manufactured range from 3 to 3000 b.hp.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GASOLINE ENGINES; MOTORBOATS, Olympia Show; OIL ENGINES.]

IRON

Electrical Resistivity

The Effect of Various Elements on the Electrical Resistivity of Iron, A. L. Norbury. Iron & Steel Inst., Paper 17, Annual Meeting, May 6 and 7, 1920, 19 pp., 2 figs. Résumé of most important papers on subject, up to and including that of Benedicks in 1902. It is shown that Benedicks' method of plotting resistivity values of quenched carbon steels on straight line and extrapolating to 7.6 microhms as resistivity of pure iron, cannot be considered as correct in view of results obtained by recent investigators, which give 9.9 microhms per centimetre cube as resistivity of pure iron at 20 deg. cent. Problem of calculating electrical resistivity of steel from its chemical composition is also briefly discussed.

Electrolytic

Some Defects in Electro-Deposited Iron, W. E. Hughes. Iron & Steel Inst., Paper 5, Annual Meeting, May 6 and 7, 1920, 18 pp., 23 figs. It is concluded from experiments and observations that electrolytic iron is liable to suffer from a number of defects that may render its use dangerous, and make it unsuitable for engineering purposes without separate heat treatment. It is believed, however, that these defects arise from causes which can be largely eliminated by efficient control and conduct of deposition process. Electrolytic iron, it is claimed, cannot be taken as pure from starting point of research work.

IRON FOUNDING

Heavy Work, Rigging for

Rigging Heavy Repetition Work, Pat Dwyer. Foundry, vol. 48, no. 12, June 15, 1920, pp. 469-472, 5 figs. Practice of Ohio foundry which during war established record of producing one complete set of castings for 2800-horsepower marine engine every day continuously for several months.

IRON ORE

Lorraine Deposits

The Lorraine Iron Field and the War, Alfred H. Brooks. Eng. & Min. Jl., vol. 109, no. 19, May 8, 1920, pp. 1065-1069, 6 figs. Annual production in 1913 was 50,000,000 tons, and 34 per cent of metallic iron used in Europe came from Lorraine ores.

Titaniferous, New Zealand

The Utilization of Titaniferous Iron Ore in New Zealand, J. A. Heskett. Iron & Steel Inst., Paper 4, Annual Meeting, May 6 and 7, 1920, 14 pp., 4 figs.; also Min. & Metallurgy, no. 162, June 1920, pp. 29-30, 2 figs. Deposits are limonite, also found as lower hydrated oxides, and combined magnetite and ilmenite. It is said that by mixing coking coal with fine iron sand found in Taranaki, New Zealand, in proportion of 1 to 1, coke or ferrocoke containing 36 per cent metallic iron and 40 per cent carbon was obtained.

Valuation

The Valuation of Ores and Iron Making Material, C. H. Ridsdale. Iron & Steel Inst., Paper 8, Annual Meeting, May 6 and 7, 1920, 30 pp. Arrangement introduced by writer for valuing iron-making material, giving at a glance approximately pig, gas and slag formers (acid and basic), respectively, grouped together.

L

LABOR

Unrest

The Modern Specialist in Unrest, E. E. Southard. Indus. Management, vol. 59, no. 6, June 1920, pp. 462-466. Thought is developed that trained psychiatrist should become the consultant of industry, particularly in regard to matters which tend to increase or lessen feelings of unrest in individuals.

[See also STRIKES, Law Governing.]

LABOR TURNOVER

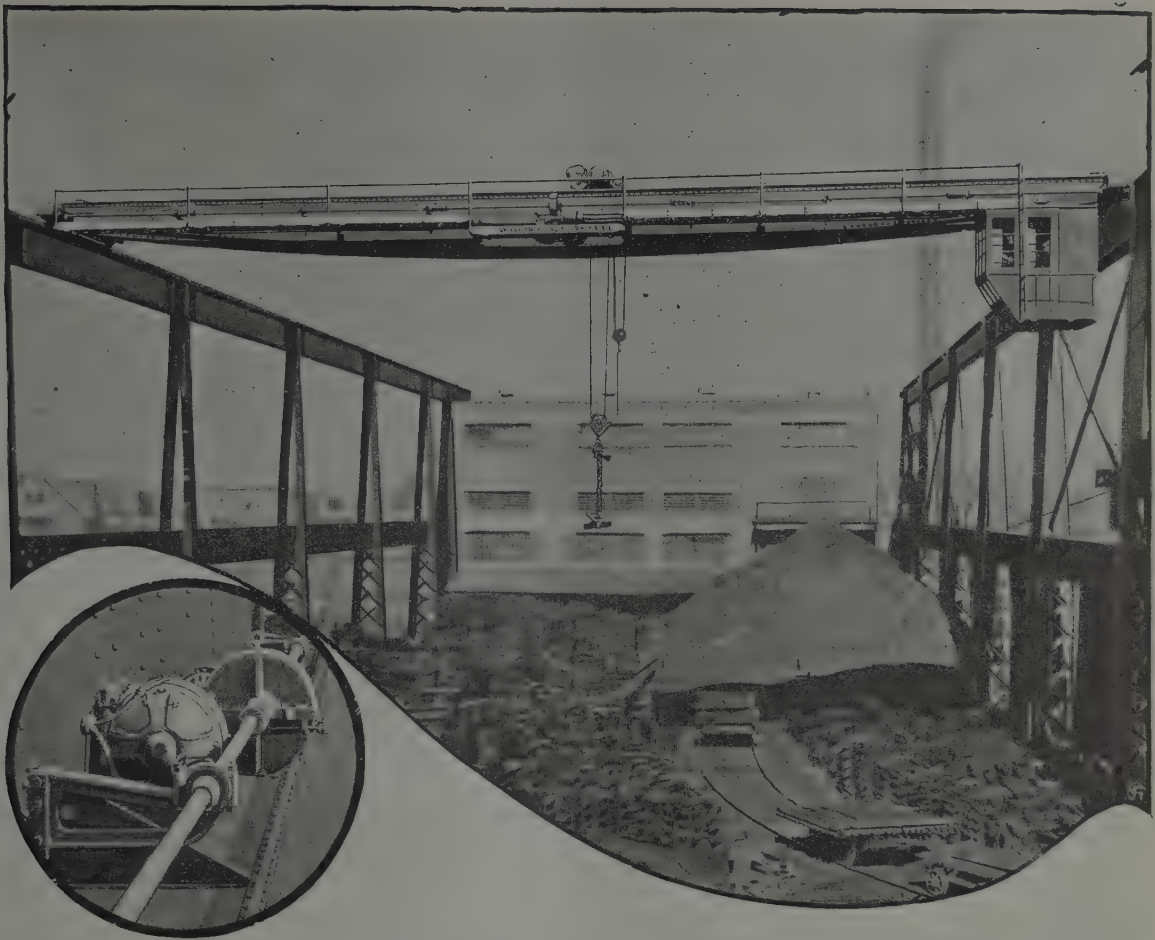
Causes

The New Employee as a Vital Factor in Labor Turnover, Norman G. Shidle. Automotive Industries, vol. 42, no. 22, May 27, 1920, pp. 1216-1218, 5 figs. It is claimed that greater part of labor turnover occurs among employees who have been in service less than two months, which condition necessitates that particular attention be given to methods of securing employment.

Reducing

Definite Analysis Methods Help Solve Labor Difficulties, Norman G. Shidle. Automotive Industries, vol. 42, no. 21, May 20, 1920, pp. 1166-1168, 2 figs. Efforts of Goodyear Tire & Rubber Co. to reduce its labor turnover and to obtain contented and satisfactory workmen.

Labor Turnover of Industrial Plants, and What Steps Can Be Taken to Minimize It, A. W. MacDonald. Iron & Steel of Canada, vol. 3, no. 4, May 1920, pp. 123-124. It is stated that most important and effective method of reducing labor turnover is establishment of employment department properly administered.



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ENGINEERING INDEX (Continued)

LABORATORIES

Aeronautic

Aeronautical Studies at the Eiffel Aerodynamic Laboratory from 1915 to 1918 (Études sur l'aéronautique faites au laboratoire aérodynamique Eiffel, de 1915 à 1918). Génie Civil, vol. 76, no. 14, April 3, 1920, pp. 325-329, 8 figs. Equipment is described, notably wind tunnel, and summary is given of principal results obtained. From book by G. Eiffel, published by Chiron, Paris.

LADDERS

Safety Code

The Requirements of the Industrial Code Relating to Ladders and Scaffolds, Peter C. Spence. Safety Eng., vol. 39, no. 5, May 1920, pp. 229-239. Records are included of results caused by falls from or due to ladders and scaffolds, through breaking, slipping, tilting, twisting, etc., in building industry for period of three years together with classification of injuries in agreement with provision of Workmen's Compensation Law. From Proc. of Am. Soc. of Safety Engrs.

LATHES

High-Speed

18-In. High-Speed Sliding and Surfacing Lathe. Eng., vol. 109, no. 2833, Apr. 16, 1920, pp. 513 and 516, 7 figs. Type constructed by Sir W. G. Armstrong, Whitworth and Co., Ltd., Manchester, and exhibited by them at Lyons Fair as maximum production machine.

Mass Production

Mass production as Applied to Machine Tools. E. W. Field. Elecn., vol. 84, no. 2189, Apr. 30, 1920, pp. 496-498, 4 figs. Notes on the production of capstan and turret lathes, with special reference to practice of H. W. Ward & Co., Ltd., to provide necessary material.

Relieving Attachment

Relieving Attachment for Lathes. Eng., vol. 109, no. 2828, Mar. 12, 1920, pp. 345-346 and 348, 12 figs. Attachment invented by E. M. Wildey, now being manufactured by Milton, Ltd., of London, for performing relieving work on ordinary screw-cutting lathe.

Turret

A New Automatic Indexing Turret. Machy. (Lond.), vol. 16, no. 395, Apr. 22, 1920, p. 87, 2 figs. Square turret especially intended for use on center lathe.

LEAD

Atomic Weight

The Atomic Weight of Lead from a Japanese Radio-Active Mineral, Theodore W. Richards and Jitsusaburo Sameshima Jl. Am. Chem. Soc., vol. 42, no. 5, May, 1920, pp. 928-930. Experiments at laboratory of Harvard University. Average determined value of atomic weight of lead was, with ordinary lead, 207.184, and with Japanese lead, 207.13.

LIFEBOATS

Motor-Driven

The Development of the Motor Lifeboat. Engr., vol. 129, no. 3351, Mar. 19, 1920, pp. 294-296, 6 figs. Comparison of self-righting and non-self-righting types.

LIFTING MAGNETS

See CRANES, Traveling.

LIGHT

Progagation in Gravitational Field

Propagation of Light in a Gravitational Field, A. O. Rankine. Lond., Edinburgh & Dublin Phil. Mag. & Jl. of Science, vol. 39, no. 233, May 1920, pp. 586-591. Experiments conducted to investigate how far it is true that velocity of light in gravitational field such as that of the earth is independent of orientation of light oscillations.

LIGHTING

Coefficients of Utilization

Coefficients of Utilization, Ward Harrison and Earl A. Anderson. Trans. of Illuminating Eng. Soc., vol 15, no. 2, March 20, 1920, pp. 97-123, 38 figs. Method is presented for direct determination of coefficients of utilization applying to installations of all ordinary types of lighting units in rooms of varied proportions and different ceiling and wall colors. As basis for method, coefficient of utilization data are tabulated from series of several hundred illumination tests made in experimental room with reflectors having three fundamental forms of light distribution. Illustrating application of data presented, typical coefficient of utilization tables, as determined for number of reflector types in common use, are included.

Walls and Floors—Their Effects on Lighting, Van Rensselaer Lansingh. Trans. of Illuminating Eng. Soc., vol. 15, no. 2, March 20, 1920, pp. 124-135 and (discussion) pp. 135-138, 9 figs. Utilization factors are given in different units of direct, semi-indirect and totally indirect types designed for gas-filled lamp when tested under varying conditions of walls and floor. Effects of variable wall and floor coverings are analyzed and their interaction explained.

Factory

Factory Lighting—A Central Station Problem, O. R. Hogue and J. J. Kirk. Trans. of Illuminating Eng. Soc., vol. 15, no. 1, Feb. 10, 1920, pp. 46-53 and (discussion) pp. 54-60, 10 figs. Data are given of a number of installations of Commonwealth Edison Co. during past year, which show tendency to improvement of artificial lighting. Data on income of central station are also included.

Glare, Measurement of

Glare Measurements, Ward Harrison. Trans. of Illuminating Eng. Soc., vol. 15, no. 1, Feb. 10, 1920, pp. 34-45, 3 figs. Data are presented showing range of agreement in opinion among number of observers as to glare from bare lamps and other more diffuse light sources, in comparison with reference source of variable intensity. Practicability of rough classification of lighting installations into groups according to sensation of glare as registered by small instrument based on this method of comparison, is discussed.

Indirect

Illumination of Artistic Interiors Without the Use of Pendant Ceiling Fixtures, Augustus D. Curtis and J. L. Stair. Trans. of Illuminating Eng. Soc., vol. 15, no. 1, Feb. 10, 1920, pp. 61-73 and (discussion) pp. 73-76, 14 figs. Examples of indirect lighting are illustrated, notably in American Theatre of Chicago, National Bank of Commerce, New York, and Hotel Commodore Lobby, New York.

Industrial

A Survey of Industrial Lighting in Fifteen States, R. O. Eastman. Trans. of Illuminating Eng. Soc., vol. 15, no. 1, Feb. 10, 1920, pp. 77-93 and (discussion) pp. 93-96, 17 figs. Based on visits to representative plants.

[See also Factory.]

Street

Intensive Street Lighting, W. D'Arcy Ryan. Gen. Elec. Rev., vol. 23, no. 5, May 1920, pp. 362-373, 12 figs. Details of "intensive white way" system of illumination installed in principal streets of various cities.

Recent Developments in Gas Street Lighting, F. V. Westermater. Am. City (Town & County Edition), vol. 22, no. 5, May 1920, pp. 490-492, 3 figs. Fixtures are illustrated and a table is given showing illuminating powers of different lamps used.

The Trend of Modern Practice in Street Lighting, W. E. Underwood. Elec. Rev. (Chic.), vol. 76, no. 24, June 12, 1920, pp. 980-983, 4 figs. Practice in connection with transformers, mounting heights, glassware and series and multiple systems.

LIGHTNING ARRESTERS

Alternating-Current

Alternating-Current Lightning Arresters, V. E. Goodwin. Gen. Elec. Rev., vol. 23, no. 5, May 1920, pp. 429-432, 8 figs. Survey of developments with special reference to aluminum-cell and oxide-film arrester.

Horn Gaps

Protection of Electric Installations Against Atmospheric Discharges and Overvoltages (Protection des installations électriques contre les décharges atmosphériques et les surtensions), A. Hayet. Revue générale de l'Électricité, vol. 7, no. 20, May 15, 1920, pp. 657-664. 15 figs. Theory of horn gaps and suggestions in regard to manner of installing horn-gap lightning arresters.

LIGNITE

Mining

See EXCAVATING MACHINES, German.

Utilization

Revolving Kiln for Making Lignite into Made-to-Order Fuel, E. L. Broome. Coal Age, vol. 17, no. 21, May 20, 1920, pp. 1046-1048, 1 fig. Experiments, it is said, have demonstrated that revolving kiln can be so regulated as to deliver semi-coke, gas and by-products.

LOCOMOTIVE BOILERS

Copper vs. Steel Tubes

Locomotive Boiler Tubes: Copper v. Steel, Gerard A. Muntz. Ry. Gaz., vol. 32, no. 18, April 30, 1920, pp. 655-656, 1 fig. First cost of steel tubes is said to be nearer one-half than one-third that of copper. Life of steel tubes is given as 120,000 train-miles, whereas life of copper tubes is put at 360,000 train-miles.

LOCOMOTIVES

British

A British Ten-Wheel-Coupled Locomotive, W. Parker. Ry. & Locomotive Eng., vol. 33, no. 5, May, 1920, p. 131, 1 fig. Description of a 4-cyclinder 0-10-0 locomotive for banking trains up an incline with gradient of 1 in 37.7 built at Derby Works for the Midland Railway of England.

New 0-10-0 Type Locomotive, Midland Railway. Ry. Engr., vol. 41, no. 484, May, 1920, pp. 205-208, 7 figs, 1 on supp. plate. Locomotive constructed at company's works at Derby for heavy banking service on the Lickey incline which has gradient of 1 in 37.7.

See also Superheater.

Cylinder Valves

New Application of Piston Valves to Slide Valve Cylinders, J. Snowden Bell. Ry. & Locomotive Eng., vol. 33, no. 5, May, 1920, pp. 142-143, 3 figs. Description and illustrations of what is said to be a new and entirely practical method of converting inside steam-pipe slide-valve locomotive cylinders into outside steam-pipe piston-valve cylinders, devised and patented by Patrick Sheedy, superintendent of motive power of Southern Pacific System at Los Angeles, Cal.

Efficiency, Increasing

How to Increase the Efficiency and Operating Capacity of Steam Locomotives, B. B. Milner. Official Proc. New York Railroad Club, vol. 30, no. 6, April 16, 1920, pp. 6069-6089 and (discussion) pp. 6089-6095, 4 figs. Suggestions in regard to installing feedwater heater and trailer booster and lightening reciprocating and revolving weights by use of alloy steel.

Electric

See ELECTRIC LOCOMOTIVES.

Fuel for

See COAL, Iowa and Illinois.

Oil-Burning

Heavy Oil as Locomotive Fuel (Le chauffage aux huiles lourdes appliqué aux locomotives), L. Pierre-Guédon. Génie Civil, vol. 76, no. 14, April 3, 1920, pp. 329-333, 10 figs. Burner for oil residue used in locomotives of Paris, Lyons and Mediterranean Railway.

Repairing

Scheduling and Routing Systems for Locomotive Repairs. Ry. Age (Daily Edition), vol. 68, no. 24a, June 11, 1920, pp. 1716-1717, 4 figs. Practices of several railroads. Committee report presented at meeting of Mechanical Section, American Railroad Assn.

Speed Indicators

Speed Indicators and Recorders for Application to Locomotives. Ry. Gaz., vol. 32, no. 22, May 28, 1920, pp. 794-795, 4 figs. Description of "Teloc" locomotive speed indicator and recorder, recently put on the market by Hasler Telegraph Works, London.

Steel for

Report on Specifications and Tests for Materials. Ry. Age, Daily Edition, vol. 68, no. 24, June 15, 1920, pp. 1795-1800, 4 figs. Practice recommended by Committee of Am. Railroad Assn., Mech. Section, in regard to method of manufacture and tests of steel for tires of locomotives and cars, boiler and fire box of locomotives, journal bearings, axles, shafts and other forgings.

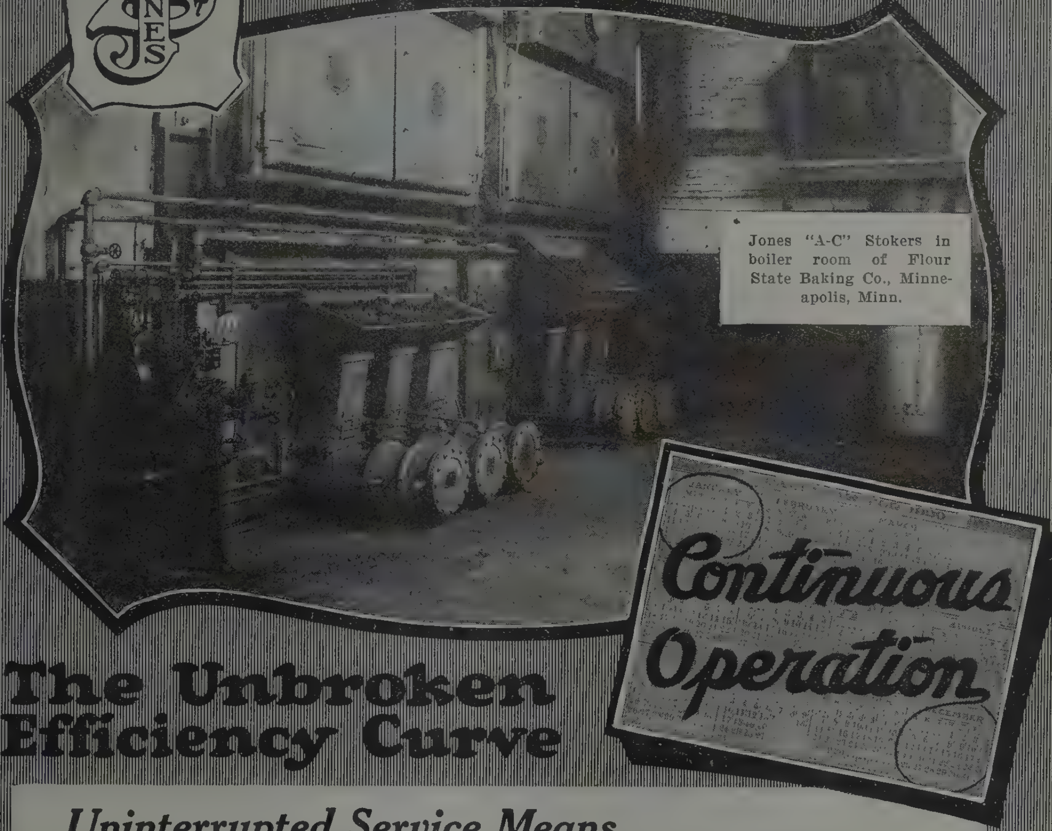
Superheater

Cylinders of 0-8-0 Type Superheater Locomotive: North-Eastern Railway. Eng., vol. 109, no. 2824, Feb. 13, 1920, pp. 208-209, 11 figs. Details of cylinders, and records of trials of locomotive.

0-10-0 Type Superheater Locomotive for the Midland Railway. Eng., vol. 109, no 2827, Mar, 5, 1920, pp. 311 and 314, 15 figs, partly on 2 supp. plates. Data: Cylinders, four, 16¾-in. diameter by 28-in. stroke; valve motion, Walschaerts; wheels, diameter, 4 ft. 7½ in.; total heating surface, 1718.25 sq. ft.; superheater surface, 445 sq. ft.; working boiler pressure, 180 lb. per sq. in.; tractive force at 85 per cent boiler pressure, 43,312 lb.; weight of engine in working order, 72 tons 13 cwt.

Report of Committee on Superheater Locomotives. Ry. Age (Daily Edition), vol. 68, no. 24a, June 11, 1920, pp. 1720-1721. Installation, operation, care, and maintenance of superheater equipment for locomotives. Committee report presented at meeting of Mechanical Section, American Railroad Assn.

JONES STOKER



Jones "A-C" Stokers in boiler room of Flour State Baking Co., Minneapolis, Minn.

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ENGINEERING INDEX (Continued)

Tender Connections

Safety Connections Between Engine and Tender. Ry. Age, (Daily Edition), vol. 68, no. 24a, June 11, 1920, pp. 1707-1711, 6 figs. It is urged that all new locomotives be built with central safety bar located immediately beneath drawbar, and where construction of locomotive and tender prevents this, that two safety bars be applied, one located on each side of drawbar and as near thereto as possible. Committee report presented at meeting of Mechanical Section, American Railroad Assn.

Wheel-Balancing Machine

Locomotive Wheel Balancing Machine. Engr., vol. 129, no. 3354, Apr. 2, 1920, pp. 354-355, 7 figs. Axle is placed on bearings which are each supported on four springs so arranged that bearings may "float" and "dither" with axle, should wheels when spun be out of strict balance.

M

MACHINE SCREWS

See BOLTS.

MACHINE TOOLS

Adjusting Strips, Slides, etc.

Recent Machine Tool Developments—XI, Joseph Horner. Eng., vol. 109, no. 2833, Apr. 16, 1920, pp. 505-508, 46 figs. Adjusting strips, and lubrication of slides.

MACHINERY

Foundations for

Fastening Machines to Concrete Floors and Foundations, Arthur F. Owen. Machy. (N. Y.), vol. 26, no. 9, May, 1920, pp. 820-821, 5 figs. Description and illustrations of common methods of fastening machine tools to concrete floors and types of drills employed to drill holes in concrete floors and foundations.

MANGANESE ORE

India, Mining

Manganese-Ore Mining in India, E. N. T. Slater. Eng. & Min. Jl., vol. 109, no. 21, May 22, 1920, pp. 1155-1159, 7 figs. Rich deposits in jungle were worked by open pits, gravity planes being used for collecting ores at loading points. Condition and prospects of industry are noted, together with marketing of ores in England.

MARINE ENGINES

See DIESEL ENGINES, Trend in Marine Types; OIL ENGINES.

MARINE STEAM TURBINES

Reduction Gears

Reduction Gearing on Steamships. Eng., vol. 109, no. 2836, May 7, 1920, pp. 599-601, 6 figs. Notes on their design.

MATERIALS

Ductile, Resistance of

On the Resistance of Ductile Materials to Combined Stresses in Two or Three Directions Perpendicular to One Another, H. M. Westergaard. Jl. of Franklin Inst., vol. 189, no. 5, May, 1920, pp. 627-640, 9 figs. Various theories for determining resistance of materials to combined stresses are discussed. In particular stress-solid resulting from application of maximum shear and maximum strain theory is indicated.

MERCHANT MARINE

Labor Problem

The Labor Problem and its Influence Upon the Merchant Marine of the Future, Waldon Fawcett. Int. Mar. Eng., vol. 25, no. 6, June, 1920, pp. 513-515. Opinion is expressed that one solution for American labor problem in maritime industries and for high costs of operation is to be found in employment of vessels of maximum size.

METALS

See CHEMICAL ANALYSIS, Metals, X-Ray.

METEOROLOGY

Free-Air Conditions

Average Free-Air Conditions as Observed by Means of Kites at Drexel Aerological Station, Nebr., During the Period November, 1915, to December, 1918, inclusive, Willis Ray Gregg. Monthly Weather Rev., vol. 48, no. 1, January, 1920, pp. 1-11, 8 figs. Tables and figures are given indicating monthly, seasonal and annual values of different elements at various levels up to 5 km. Data are compared with similar data for Mount Weather, Blue Hill and elsewhere, and separate table contains comparative values of air density as determined by different investigators for various parts of the world.

Predicting Minimum Temperatures

Predicting Minimum Temperatures from Hygrometric Data, J. Warren Smith. Monthly Weather Rev., Supp. no. 16, 76 pp., 57 figs. Application of mathematical methods to forecast minimum temperatures is exemplified.

METRIC SYSTEM

Arguments Against Adoption in U. S.

Adoption of the Metric System Would Do Untold Damage, Henry R. Towne. Indus. Management, vol. 59, no. 6, June, 1920, pp. 473-477. Abandonment of present basic standards would involve, it is claimed, damage beyond easy comprehension, injury to organized industries, injury to commerce and needless inconvenience to the people.

MILLING MACHINES

Ingersoll

Application of New Ingersoll Milling Machines. Machy. (N. Y.), vol. 26, no. 9, May, 1920, pp. 810-816, 19 figs. These machines are equipped with two or more work-holding fixtures so that a machine is milling a casting held in one fixture while operator is setting up work in another, thus preventing idle machine time.

Multiple-Spindle

Special Multiple-Spindle Milling Machines. Machy. (N. Y.), vol. 26, no. 9, May, 1920, pp. 856-862, 15 figs. For milling naval gun mountings.

Thread

Gray Thread Milling Machines. Machy. (N. Y.), vol. 26, no. 9, May, 1920, pp. 875-876, 2 figs. Description of new line of thread millers developed by the Gray Machine Tool Co., Inc., Buffalo, N. Y., which, it is said, will handle bar work, work held in a chuck, or work held between centers.

MINE HAULAGE

Electric

Rope-Haulage Methods and Equipment That Have Given Success at Lethbridge, Alta, J. B. DeHart and J. H. Turner. Coal Age, vol. 17, no. 22, May 27, 1920, pp. 1081-1084, 21 figs. Details of three motor-driven haulages, using ¾-in. Lang lay crucible cast-steel haulage ropes.

MINE LOCOMOTIVES

Electric

A New Type of Gathering Locomotive, John Liston. Gen. Elec. Rev., vol. 23, no. 5, May, 1920, pp. 446-450, 8 figs. Electric locomotive equipped with electric braking controller.

MINES

Taxes, Effect on Mine Accounting

Tax Problem Effect on Mine Accounting, Henry B. Fernald. Min. & Metallurgy, no. 160, April, 1920, pp. 16-18. Overlapping of state and federal tax laws is pointed out and its effect on mine accounting discussed.

Water-Neutralization Plant

Mine-Water Neutralization Plant at Calumet Mine, L. D. Tracy. Min. & Metallurgy, no. 161, May, 1920, pp. 29-30, 1 fig. Plant neutralizes water and extracts six tons of ferric oxide per day from it as byproduct.

MINING

Cost Reduction in

Opportunities for Reducing Mine Costs by Standardizing Equipment, Warren R. Roberts. Coalage, vol. 17, no. 25, June 17, 1920, pp. 1266-1268. Uniform mine-track gages and tipple clearances advocated to reduce accidents and as beneficial to operator and manufacturer.

MOTOR BOATS

Monaco Meeting

The Twelfth Meeting of Motor Boats at Monaco (Le XIIe meeting de canots automobiles de Monaco). G. Birlé. Génie Civil, vol. 76, no. 20, May 15, 1920, pp. 445-449, 12 figs. Various types of cruisers, racers and gliders with aeroplane propellers are described and illustrated.

Olympia Show

The Motor Boat and Marine and Stationary Engine Exhibition—I. Engr., vol. 129, nos. 3351, 3352 and 3353, Mar. 19 and 26 and Apr. 2, 1920, pp. 302-303, 320-322, 7 figs. and 345-348, 5 figs. Striking features of principal types exhibited. Mar. 26: Gleniffer 6-cyl. engine and propeller-reversing gear, and Bolnes hot-bulb engine. Apr. 2: Thornycraft kerosene engines and Beardmore hot-bulb engines.

The Motor-Boat Exhibition at Olympia. Eng., vol. 109, nos. 2829 and 2830, Mar. 19 and 26, 1920, pp. 372-375, 12 figs., and 406-408, 8 figs. Details of models exhibited.

What the British Motor Makers are Doing, M. W. Bourbon. Motor Boat, vol. 18, no. 10, May 25, 1920, pp. 25-29, 16 figs. Review of English practice based on exhibits at Olympia show.

[See also TRACTOR ENGINES, Motor Boats, Adapting to.]

MOTOR-TRUCK TRANSPORTATION

Long-Distance

Engineering Problems of Long Distance Motor Transport. Automotive Industries, vol. 42, no. 22, May 27, 1920, pp. 1193-1195. Experiences of Motor Transport Corps in recent transcontinental trip.

MOTOR TRUCKS

Electric

70-Cwt. Electric Battery Tipping Wagon. Eng., vol. 109, no. 2831, Apr. 2, 1920, pp. 446-448, 8 figs. Truck manufactured by Messrs. Ransomes, Sims and Jefferies, Ltd., Ipswich, England.

Municipal Service, English Types for

Types of motor Trucks in Use by the Municipalities in England, M. W. Bourdon. Automotive Industries, vol. 42, no. 22, May 27, 1920, pp. 1200-1202, 8 figs. Types of fire engines, street cleaners, tipping bodies and other machines.

Pneumatic-Tired

Equipment Design for Use on the Pneumatic Tired Truck, J. Edward Schipper. Automotive Industries, vol. 42, no. 21, May 20, 1920, pp. 1152-1153. Modifications which will be introduced in design of engines, gear sets, rear axles, tires and wheels of a pneumatic tired truck.

Specifications

Internal-Combustion Truck Specifications. Power Wagon, vol. 24, no. 187, June, 1920, pp. 38-55. Table giving particulars for 570 American makes.

[See also AUTOMOBILES, Uses in War.]

MOTORSHIPS

Danish

The Twin-Screw Motor Ship "Afrika." Eng., vol. 109, no. 2834, April 23, 1920, p. 546 and p. 550, 3 figs. Built by Copenhagen firm to class 100 AI, British Lloyd's special survey, awning deck with freeboard, and with certificate for carrying fuel oil in double bottom. Length is 464 ft. 6 in. overall, breadth 60 ft., and depth molded to lower deck, 24 ft.

N

NATURAL GAS

Industry in U. S.

U. S. Natural Gas Production, E. G. Sievers. Gas. Rec., vol. 17, no. 10, May 26, 1920, pp. 51-54. Situation of natural gas industry. Number of producing wells has increased 135 per cent since 1906, and was about 40,500 at end of 1918. About 76 per cent of production is not consumed where produced but is piped to other states. United States produces about 95 per cent of natural gas produced in the world.

Pipe Lines, Welded

The Transportation of Natural Gas, C. E. Brock. Oil News, vol. 8, no. 3, Jan. 5, 1920, pp. 13-16, 6 figs. Details of welded lines, with table giving results of tests on strength of welds made by Kansas City Testing Laboratory.

[See also GASOLINE, Natural-Gas.]

NAVIGATION

Rhone-Rhine

The Swiss Rhone-Rhine Navigation—III and IV, A. Wharton Metcalfe. Engr., vol. 129, nos. 3351 and 3353, Mar. 19 and Apr. 2, 1920, pp. 290-291, 2 figs., and 341-342, 1 fig. Rhone-Lake of Geneva junction section. Apr. 2: Lake of Neuchatel and Rhine junction section.

NAVY YARDS

New Orleans, War Work of

The Navy Yard at New Orleans, Fred H. Colvin. Am. Mach., vol. 52, no. 21, May 20, 1920, pp. 1073-1075, 8 figs. Work done during the war.

Number Four
of a Series

Working Points

(Not Talking Points or Selling Points)

of the Hartness Flat Turret Lathe

Multiple Stops

When is a tool as good as two?

When you can apply two sets of stops to the tool.

When is a tool as good as a whole special tool holder with a number of cutting tools?

When you combine a cross sliding head with Multiple Stops.

What offers this combination?

The Hartness Flat Turret Lathe

The stops for the turret slide are clamped solid in the bed between the ways. There is no better place.

There are twelve in all, two for each turret position.

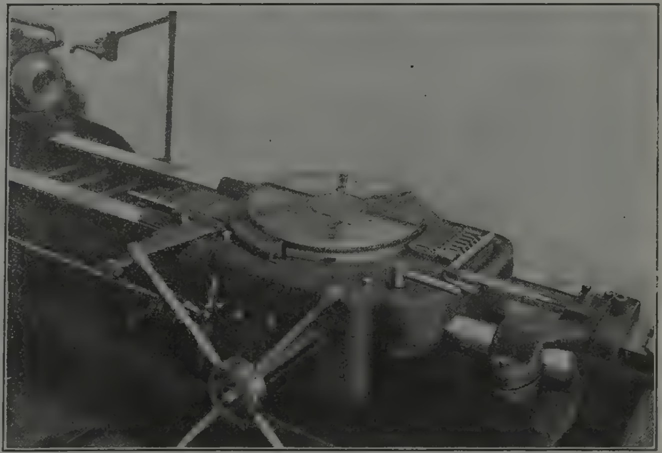
One set of six comes automatically into operation as the turret revolves.

The shifting of a lever brings the second set automatically into action.

In addition, any or all of the second set of six may be applied to any one position, giving a maximum of service.

Lastly, there are nine stops for the Cross Sliding Head, any or all of which may be applied to one turret position.

This is really all you will need in the way of stops; but you will have to buy a Hartness Flat Turret Lathe to get them.



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SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

ENGINEERING INDEX (Continued)

NEEDLES

Sewing-Machine, Manufacture of

Manufacturing of Sewing Machine Needles, Carlos Ruiz. Machy. (N. Y.), vol. 26, no. 9, May, 1920, pp. 834-836, 3 figs. Brief outline of general procedure in manufacture of sewing-machine needles and description of turret machine used in connection with performance of fourth, fifth and sixth operations, there being fifteen operations required in all which are shown diagrammatically.

NICKEL STEEL

Commercial

Critical Ranges of Some Commercial Nickel Steels, Howard Scott. Sci. Papers of Bur. of Standards, no. 376, April 6, 1920, pp. 195-214, 11 figs. Survey of work undertaken by different investigators and results of experimental work. It was found that critical range Ar_3 on cooling iron-nickel alloys is lowered nearly linearly to absolute zero for about 34 per cent nickel, and critical range Ar_1 and Ar' of pearlitic nickel steels is lowered with increasing nickel content until region of complete martensitization is reached, when transformation Ar'' alone is found at much lower temperature. Critical ranges were determined for six commercial nickel steels of 0.30 to 0.40 per cent C, 0.55 to 0.75 per cent Mn, 0.15 to 0.30 per cent Si contents, and nickel varying from 0 to 3.5 per cent, together with pure iron-carbon alloy of 0.40 per cent C content.

NITRATES

Chilean Deposits

The Chilean Nitrate Deposits, W. L. Whitehead. Economic Geology, vol. 15, no. 3, April-May, 1920, pp. 187-224, 33 figs. Theory that deposits are of volcanic origin is examined in the light of information gathered in survey of regions.

Sahara

Nitrate Deposits in the Sahara (Gisements de nitrates au Sahara), M. Guillaume. Annales des Mines, vol. 9, no. 4, April, 1920, pp. 181-246, 10 figs. Report of exploring commission sent out by French Ministry of War. (To be continued.)

NITRIC ACID

Manufacture

War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes, James Walker. Jl. Chem. Soc., vol. 117 & 118, no. 690, April, 1920, pp. 382-389. Work done under auspices of Chemistry Department of Edinburgh University.

NITROGEN

Atmospheric, Utilization of

Utilization of Atmospheric Nitrogen, Thomas H. Norton, Dept. of Commerce & Labor Bur. of Manufactures, Special Agents Series no. 52, 1912, 178 pp. 5 figs. Deals with present supply of nitrogen, synthetic production of ammonia, synthesis of nitric acid, hydrocyanic acid, cyanides, nitrides and calcium cyanamide from atmospheric nitrogen and coal waste and peat as sources of ammonia.

Fixation of

Development and Present Status of the Problem of Fixation and Utilization of Atmospheric Nitrogen (Die Entwicklung und der gegenwärtige Stand des Problems der Bindung und Nutzbarmachung des Luftstickstoffes). Elektrotechnischer Anzeiger, vol. 36, nos. 128, 139 and 145, Nov. 11, 29 and Dec. 10, 1919, pp. 609-610, 660-664 and 694-696, 8 figs. Details of construction and operation of the Haber furnace, and of various catalyzers. Notes on absorption of nitrogen by metals in form of nitrites, absorption of nitrogen as cyanide and oxidation of ammonia. If consumption of cokes, coal and other fuel be expressed in units of electric power, it is stated that for the direct synthesis of ammonia per kw.-yr. about 830 kg. nitrogen is required, with the help of the cyanamide process about 380 kg., and with the help of the electric arc process about 130 kg., and advantages and disadvantages of the three processes are pointed out. (Concluded.)

The Fixed Nitrogen Research Laboratory, Arthur B. Lamb. Chem. & Metallurgical Eng., vol. 22, no. 21, May 26, 1920, pp. 977-979, 11 figs. Brief statement with illustrations of Government investigations being made on cyanamide, Haber and arc processes for producing fixed nitrogen. National aspects of problem.

NON-FERROUS METALS

Use in Naval Machinery

The Use of Non-Ferrous Metal in Naval Machinery, George Goodwin. Eng., vol. 109, no. 2828, Mar. 12, 1920, pp. 354-355. Surveying development of naval machinery, attention is directed to use of non-ferrous metals in condenser tubes, propeller blades and bearing metals. Paper read before Inst. of Metals.

O

OIL ENGINES

Marine

Oil Engines of the Motor Ship "Narragansett." Eng., vol. 109, no. 2836, May 7, 1920, pp. 623-624, 1 fig. There are two sets of Vickers solid-injection type oil engines designed to develop in conjunction 2500 b.hp. at 118 r.p.m.

OIL FIELDS

Geology of

Geologic and Economic Features of Oil Structures, Victor Ziegler. Economic Geology, vol. 15, no. 3, April-May, 1920, pp. 247-258. It is claimed that (1) comparatively recent age of formation, (2) slight folding, very closely following period of deposition, and (3) rock originally rich in organic remains, are features favoring maximum accumulation of oil.

Russia

The Oil Fields of Russia, A. Beeby Thompson. Min. & Metallurgy, no. 161, May, 1920, pp. 27-29. Notes on Baku oil fields. Operated area of 250 acres is said to have produced over 500,000 bbl. per acre.

OIL FUEL

See Petroleum.

OIL PUMPS

Force-Feed

The Hansa Force-Feed Oil Pumps and Oil Control Apparatus (Die Hansa-Druckschmierpumpen und Oelkontrollapparate). Motorwagen, vol. 22, no. 36, Dec. 31, 1919, pp. 701-703, 3 figs. Description and illustrations of a simple design of valveless piston pump and a visible oil controller, both patented by the Hansa Metal Works of Stuttgart-Feuerbach.

OIL TANKS

Reinforced-Concrete

Concrete Storage Tanks for Fuel Oil Square and Circular, R. E. Parker. Concrete, vol. 16, no. 5, May, 1920, pp. 213-217, 11 figs. Two types, one circular and one rectangular, built by Aberthaw Construction Co., are illustrated and described.

Steel

New Design for Oil Tankage, H. T. Carlton. Eng. & Min. Jl., vol. 109, no. 19, May 8, 1920, pp. 1078-1079, 2 figs. Type developed by D. O'Hara and A. L. Shaw, of San Francisco involving suspended steel "arch," which has recently been patented.

OIL WELLS

Drilling

Drilling an Oil Well in Pennsylvania, Herbert T. Wade. Sci. Am. Monthly, vol. 1, no. 6, June, 1920, pp. 524-527, 6 figs. Methods of boring and details of machinery used.

OILS

Blended, Viscosity of

The Saybolt Viscosity of Oil Blends, Winslow H. Herschel. Chemical & Metallurgical Eng., vol. 22, no. 24, June 16, 1920, pp. 1109-1112, 3 figs. Charts for determining oil blends of components of known viscosity, including logarithmic rule and correction factors to be applied in calculations, and tables of viscosities of blends containing 25, 50 and 75 per cent of heavier oil.

OPEN-HEARTH FURNACES

Waste-Heat Utilization

Steel Plant Power Generation from Waste Heat and Coal, B. H. Greene. Assn. of Iron & Steel Elec. Engrs., Jan., 1920, pp. 25-37, 3 figs. Writer presents some practical problems encountered in utilization of waste heat from open-hearth furnaces for generation of power for steel mill use. Description of an installation, wherein steam derived from waste heat was supplemented by coal-fired boilers and used for electric power generation.

OSCILLATIONS

Electrical

Damped Oscillations in Coupled Circuits, G. Bramwell Ehrenborg. Radio Rev., vol. 1, no. 8, May, 1920, pp. 375-380, 1 fig. Mathematical evaluation of electrical quantities. (Concluded.)

Oscillations Obtained by Coupling a Secondary Circuit with a Continuous Wave Valve Oscillator, J. S. Townsend. Radio Rev., vol. 1, no. 8, May, 1920, pp. 369-374, 6 figs. Equations expressing frequencies of free oscillations when two oscillatory circuits are coupled by mutual induction between coils.

OXY-ACETYLENE CUTTING

Manhole-Cutting Machine

Oxy-Acetylene Manhole Cutting Machine. Eng., vol. 109, no. 2836, May 7, 1920, p. 606, 4 figs. Machine constructed by Davis-Bournonville Co., Jersey City, for repetition cutting of manholes to template.

OXY-ACETYLENE WELDING

See AUTOGENOUS WELDING.

P

PACKING

See BOXES.

PAPER MANUFACTURE

Pulp-Grinder Speed Control

Increasing Efficiency by Speed Control of Turbine-Driven Pulp Grinders, Adolph F. Meyer. Paper, vol. 26, no. 11, May 19, 1920, pp. 11-19, 14 figs. Method of controlling speed of hydraulic turbines is explained, and tachometer charts are given showing results secured with governor under average conditions.

PARACHUTES

Static Burns

Recent Data on Parachutes, Floyd Smith. Aviation, vol. 8, no. 9, June 1, 1920, pp. 369-370. Experimental study of friction static burns developed in silk parachutes.

PAVEMENTS

Labor Requirements

Method of Estimating Labor Hour Requirements on Paving Work, D. B. Davis. Eng. & Contracting, vol. 53, no. 18, May 5, 1920, pp. 508-509, 7 figs. Writer points out that in making an estimate of certain work a chart showing various conditions relating to work will help to guarantee against omission of important details. Brief study for determining labor-hour requirements for some divisions of work connected with a brick paving job in a city is included.

PAVEMENTS, ASPHALTIC CONCRETE

Types

Asphaltic Concrete Pavement, W. H. Connell. Can. Engr., vol. 38, no. 24, June 10, 1920, pp. 543-544, 559 and 561. Best asphaltic concrete pavement, writer has found in his experience as road builder, is a patented one which specifies 7½ per cent of asphalt, 8 to 10 per cent of limestone or Portland cement dust, 50 to 55 or 60 per cent of stone and 25 to 30 per cent of sand.

PAVEMENTS, STONE

Granite-Block

Granite Block on Old Concrete Base. Public Works, vol. 48, no. 19, May 22, 1920, pp. 441-442, 1 fig. Repaving part of Park Avenue, New York, for heavy traffic, with granite blocks replacing asphalt blocks on original base.

PEAT

Pulverized

Pulverized Peat Firing in Sweden (Die Torfstaubfeuerung in Schweden), P. Wangemann. Feuerungstechnik, vol. 8, no. 7, Jan. 1, 1920, pp. 53-58, 16 figs. It is pointed out that in America the difficulty of pulverized coal firing was overcome by increased drying and finer grinding, whereas in Sweden the opposite method was employed of adapting burner to coarser material with greater water content, both methods proving successful. Advantages and disadvantages of both methods are discussed. Results of experiments are said to show that pulverized peat firing results in higher superheat temperature than anthracite firing.

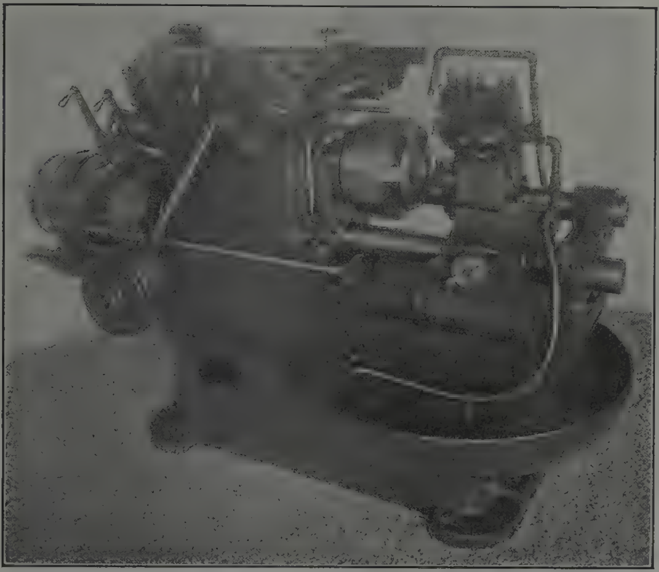
PETROLEUM

Colombian Law

The Colombian Petroleum Law, J. W. Thompson. Eng. & Min. Jl., vol. 109, no. 21, May 22, 1920, pp. 1170-1172. Regulations concerning development and providing royalties to be paid. Foreign companies required to have local representatives. Development or production tax of 8-6-4 per cent, determined by distance from sea coast.

FAY AUTOMATIC LATHE

First Operation on Ring Gear



The above photograph shows the first operation on a ring gear on a Fay Automatic Ring Bevel Gear Lathe.

The back arm faces the back of the gear.

The piece is finished in the time it takes this facing tool to complete the cut.

The front carriage, rough and finish bores the hole, and then rocks into face the inside of the web.

This is a quick and efficient operation.

The second operation will be shown next month.

The Fay Lathe is completely described in a catalogue that we send on request.

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ENGINEERING INDEX (Continued)

U. S. Supply

Relief from Oil Shortage, Oswald F. Schuette Gas Age, vol. 45, no. 9, May 10, 1920, pp. 422-423. Proposals under consideration by United States Congress for obtaining fuel oil for United States vessels.

PETROLEUM INDUSTRY

Progress 1916-18

The Petroleum Industry in the Years 1916-1918 (Die Erdölindustrie in den Jahren 1916-1918), Richard Kissling. Chemiker-Zeitung, vol. 43, nos. 153, 154 and 155, Dec. 20, 23 and 25, 1919, pp. 897-899, 905-909, and 913-917. A review of production and of literature, patents, processes, etc., from all parts of the world.

PHASE MODIFIERS

Commutator Type

Commutator Phase Shifters (Ueber Kommutator-Phasenschieber), J. Kozisek. Elektrotechnische Zeitschrift, vol. 41, no. 3, Jan. 15, 1920, pp. 52-55, 15 figs. Notes on effect of saturation and extension of compensating field. Other means of extension, such as three-phase regulation of phase shifters, excess compensation at full load, etc., are discussed.

PHOTOMETERS

Photoelectric

A Photoelectric Photometer, Arthur H. Compton. Trans. of Illuminating Eng. Soc., vol. 15, no. 1, Feb. 10, 1920, pp. 28-33., 1 fig. Use of thermionic amplifier to increase current readings of photoelectric cells is suggested, also filter to reduce proportion of blue light and render indications proportional to photometric value. With such equipment, lamps are compared by varying their distances to cell, until deflection of galvanameter is the same as that given by standard lamp.

Photometric Integrator

A Universal Photometric Integrator, Frank A. Benford. Trans. of Illuminating Eng. Soc., vol. 15, no. 1, Feb. 10, 1920, pp. 19-27, 12 figs. Apparatus for testing military searchlights. It consists of photometer track 150 ft. long on which rides hemispherical light-collecting shell with small portable-type photometer attached and system of curtains along track to absorb stray light.

PIERS

Design

Pier Design for Ocean and Lake Terminals, H. McL. Harding. Int. Mar. Eng., vol. 25, no. 6, June, 1920, pp. 523-528, 11 figs. It is advanced that single-unit piers about 700 ft. long to be used by freight-carrying ships should be 140 ft. to 150 ft. wide, with slips 280 ft. to 300 ft. wide. Suggestions are made in regard to equipment to install.

PIPE LINES

Fuel-Oil

Crude Oil and Kerosene (La mazout et le pétrole lampant), Auguste Pawlowski. Génie Civil, vol. 76, no. 16, Apr. 17, 1920, pp. 365-370, 3 figs. Notes on importation of fuel oil into France, particularly on projected pipe line from Havre to Paris.

PIPE, WROUGHT-IRON

Manufacture

Manufacture of Wrought Iron Pipe, N. Bowland. Machy. (N. Y.), vol. 26, no. 9, May, 1920, pp. 844-849, 20 figs. Description of various steps in production of wrought-iron pipe, beginning with puddling process and ending with inspection.

PIPING

Calculations for

A Graphic Method for the Calculation of Steam and Air Piping (Eine allgemeine graphische Methode, angewendet bei der Berechnung der Dampf- und Luftleitungen), Alexander Fischer. Zeitschrift für das gesamte Turbinenwesen, vol. 16, no. 36, Dec. 30, 1919, pp. 391-393. Description of a general method by means of which it is said to be possible to make calculations of quantities and in which the functional relationship between quantities is given in the form of a diagram or table of figures. In complicated cases in connection with the logarithmographic method of Mehmke it is said to arrive at results rapidly.

Power-Plant

Design and Construction of Power-Plant Piping, John D. Morgan. Power, vol. 51, no. 20, May 18, 1920, pp. 797-799, 2 figs. Suggestions regarding design and construction of piping, including materials used, valves, fittings and types of joints for various pressures and temperatures.

POWER FACTOR

Polyphase Circuits

Power Factor in Polyphase Circuits. Jl. Am. Inst., Elec. Engrs., vol. 39, no. 6, June, 1920, pp. 538-546, 8 figs. Symposium of annual conference papers. A preliminary report of special joint committee appointed by Am. Inst. Elec. Engrs. and Nat. Elec. Light Assn. is included. The committee suggests two forms for definition of power factor: (1) as ratio of total watts to arithmetical sum of volt-amperes in several phases, each measured to non-inductive neutral point and (2) as ratio of total watts to vector sum of volt-amperes in several phases.

Variations

Variations of Power Factor in Terms of Variations of Active Component (Les variations du facteur de puissance en fonction des variations de la composante active), P. Rieunier. Revue générale de l'Électricité, vol. 7, no. 22, May 29, 1920, pp. 715-726, 9 figs. Formulæ and graphs. (To be continued.)

POWER GENERATION

Financial Aspect of

Power Production and Lower Prices. L. W. Alwyn-Schmidt. Power Plant Eng., vol. 24, no. 11, June 1, 1920, pp. 555-557. Discusses financial side of power-plant engineering.

POWER TRANSMISSION

Sonic Waves

Notes on the Sonic Waves (Note sur les ondes soniques), J. Herck. Bul. Technique du Bureau Veritas, vol. 2, no. 4, April, 1920, pp. 69-73, 5 figs. Experiments performed and results obtained by George Constantinesco, Roumanian engineer, who, while working for British Admiralty, is said to have developed apparatus which demonstrate that power can be transmitted through a liquid by "sonic" waves, that is, waves behaving remarkably similarly to electrical energy and traveling with speed of sound in liquid. A device for oil injection on Diesel engines is mentioned as one of Mr. Constantinesco's notable applications of sonic waves.

Transmission Through Liquids of the Mechanical Energy of Acoustic Vibrations. Mechanism Invented by G. Constantinesco (La transmission de l'énergie mécanique par les liquides au moyen des vibrations acoustiques (sonicité), système G. Constantinesco). Génie Civil, vol. 76, no. 15, April 10, 1920, pp. 358-359. A "sonic" generator consists of a cylinder, in which a valveless piston can oscillate very rapidly, a long pipe and a steel bottle, the three being connected and filled with water or oil at very high pressure. If, the piston is caused to oscillate at a high frequency, the pipe, it is said, becomes heated and if bent into spiral will raise to boiling point temperature of water placed inside spiral. It is added that inventor has constructed a "sonic" gun which can throw 100-kg. projectile a distance of 1500 m. without making any noise and without firing any substance. From Annales des Mines de Roumanie.

PRESS WORK

Drawing Square-Cornered Shells

Drawing and Trimming Square-Cornered Shells (Ziehen and Beschneiden viereckiger Hülsen). Werkstattstechnik, vol. 14, no. 1, Jan. 1, 1920, pp. 13-16, 15 figs. Gives instructions for the predetermination of shape and measurements of tools and forms, and describes methods of drawing and trimming shells of square and of rectangular section.

PRESSES

Sub-Presses

Design of Sub-Presses, D. H. Chason. Machy. (N. Y.), vol. 26, no. 9, May, 1920, pp. 841-843, 7 figs. Description of cylinder and pillar types, ways of mounting and method of making pillar-type sub-presses.

Tools for, Design of

An Interesting Press Tool Problem. Eng. Production, vol. 1, no. 6, June, 1920, pp. 211-212, 5 figs. Tools designed for production of piece with sharp points.

PULVERIZED COAL

Aero-Pulverizer

The Aero-Pulveriser. Engr., vol. 129, no. 3351, Mar. 19, 1920, pp. 306-307, 3 figs. Machine used by Powdered Fuel Plant Co., Ltd., Westminster, England, which, in one self-contained unit, reduces coal to requisite fineness for burning in furnaces and also feeds it into furnace.

Cost of Preparation

Pulverized Coal for Stationary Boilers, H. F. Barnhurst. Combustion, vol. 2, no. 5, May, 1920, pp. 18-20, 2 figs. It is pointed out that pulverized coal should be dried before it is used, and thus uniform temperature conditions can be maintained in furnace. Cost of preparing coal compares favorably, it is said, with handling cost of stokers in medium-size installations, and in larger installations cost of investment and of preparation is considerably less than that required for up-to-date stoker installations and their operation; and flexibility of operation is said to be equal to that of oil or natural gas.

PYROMETERS

Automatic Regulating

Automatic Regulation of Temperature in Gas Heating Apparatus (Selbsttätige Temperaturregelung der Gasfeuerstätten), H. Fink. Werkstattstechnik, vol. 14, no. 2, Jan. 15, 1920, pp. 44-47, 12 figs. Automatic regulating pyrometer designed by author for use in furnaces, ovens, etc.

Q

QUAY WALLS

Reinforced-Concrete

Reinforced-Concrete Sheet Piling for Quay Walls (Murs de quai en pieux-palplanches en béton armé), Ch. Dantin. Génie Civil, vol. 76, no. 19, May 8, 1920, pp. 425-427, 8 figs. Construction at Kenitra, Morocco.

R

RADIATION

Solar, Measurement of

A New Spectrophyheliometer and Measurements of the Component Radiations from the Sun and from a Quartz-Mercury Vapor Lamp, W. W. Coblentz and H. Kahler. Dept. Commerce, Sci. Papers of Bur. of Standards, No. 378, Apr. 9, 1920, pp. 233-247, 3 figs. Apparatus consists of quartz spectograph and cylindrical quartz condensing lens placed upon simple equatorial mounting. Collimating telescope is pointed directly toward sun in order to avoid ultra-violet absorption which occurs in heliostat mirrors. Radiometric measurements are made by means of specially constructed bismuth-silver thermopile.

RADIO COMMUNICATION

Submarine

Contribution to the Study of Submarine Radio Communications (Contribution a l'étude des radiocommunications sous-marines), Leon Bouthillon. Revue générale de l'Électricité, vol. 7, no. 21, May 22, 1920, pp. 696-700, 2 figs. Theoretical study. Reference is made to experiments conducted during the war by French and American navies for investigating laws regulating radio communication between land station and a submarine.

RADIOTELEGRAPHY

Antennæ

Antenna Characteristics and Wave-Lengths of Antennae (Constantes d'antenne et longueurs d'ondes d'antennes), A. Press. Révue générale de l'Électricité, vol. 7, no. 17, April 24, 1920, pp. 547-552, 5 figs. Technical. It is found that inductance of a vertical antenna varies with height above ground. Resulting difference in inductance when antenna is horizontal is indicated. It develops that in order that an antennæ group be equivalent to a terminal capacity, wave length employed must be at least three times larger than the fundamental wave length.

Audion Connections

Audion Connections (Ueber die Schaltungsweisen des Audions), D. Coster. Physikalische Zeitschrift, vol. 20, no. 24, Dec. 15, 1919, pp. 579-584, 9 figs. Discussion of connections with which it is possible by means of a battery to generate alternating current of a determined period. Writer claims to have demonstrated that the audion must be regarded as an alternating-current exciter with constant internal resistance.

Experiments

Some Wireless Wonders, A. A. Campbell Swinton. Wireless World, vol. 8, no. 2, Apr., 1920, pp. 47-42, 6 figs. Discussion of thermionic valve or tube, and practical demonstration of experiments in wireless telegraphy received without use of any external aerial, waves being received inside the room by means of a flat coil, or loop, only about a yard in diameter.

Harmonics in Current-Wave Transmission

Harmonics in C. W. Transmission, L. A. T. Broadwood. Wireless World, vol. 8, no. 3, May, 1920, pp. 82-91, 15 figs. Main faults of this type of circuit are said to be that (1) grid is over-excited, which is responsible for

Here Is Action For You

We have tried to catch, in this photograph, some impression of the intense activity that is characteristic of this "BLISS" No. 69 N, Double Action Cam Drawing Press in the plant of the Aluminum Specialty Co., Manitowoc, Wis., throughout every minute of the working day.

It is cutting, drawing and lifting out bowls for soup ladles from 26 gauge, 6″ strip aluminum at the rate of 5000 per 10 hours.

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ENGINEERING INDEX (Continued)

flat-topped plate wave; (2) there is no arrangement to correct grid voltage to insure that oscillations will take place about mid-point of characteristic, hence plate wave is likely to be asymmetrical; (3) as aerial is directly connected to plate coil, any harmonics in plate current wave will certainly resonate on aerial which has distributed inductance and capacity.

Stations

Tropical Radio Telegraph Company. Telegraph & Telephone Age, vol. 38, no. 10, May 16, 1920, pp. 272-275, 5 figs. Equipment of long-distance stations operated by Tropical Radio Telegraph Co., a subsidiary of United Fruit Co.

[See also ELECTRIC GENERATORS, A. C., High-Frequency; OSCILLATIONS; VACUUM TUBES.]

RADIOTELEPHONY

Transcontinental

Is Wireless Telephony Feasible between Transcontinental Stations (Ist die drahtlose Telephonie als Verkehrsmittel für Ueberlandzentralen geeignet). J. Nübel. Elektrotechnische Zeitschrift, vol. 41, no. [illegible] Feb. [illegible] pp. 125-128. The telephone systems with and without wires with regard to their employment for long distance telephone plants are compared from technical and economic standpoint, and it is found that wireless system is less favorable from both standpoints.

RAILWAY ELECTRIFICATION

Mine Railways

Electric Operations—Butte, Anaconda & Pacific, F. W. Bellinger. Ry. Age, vol. 65, no. 24, June 11, 1920, pp. 1657-1658, 2 figs. The capacity of the Smelter Hill line is said to have been increased 108 per cent since road was electrified.

Railway Bond for Trunk Line

Bonding and Bond Testing on Electrified Steam Roads, John W. Logan, Jr. Elec. Ry. Jl., vol. 55, no. 24, June 12, 1920, pp. 1191-1192. Experiences on Pennsylvania Railroad electrification at Philadelphia are interpreted as indicating that for trunk lines different equipment from that developed for street railways is needed.

Rolling Stock

Design, Maintenance and Operation of Electric Rolling Stock. Ry. Age (Daily Edition), vol. 68, no. 24a, June 11, 1920, pp. 1711-1716. Development of important electrification projects on American steam railroads. Committee report presented at meeting of Mechanical Section, American Railroad Assn.

RAILWAY MAINTENANCE

Tie Renewals

A Study of the Influence of Treated Timber, Lowry Smith. Ry. Maintenance Engr., vol. 16, no. 6, June 1920, pp. 224-225, 2 figs. Charts showing theoretical effect of use of treated timber upon annual cross-tie requirements. Paper read before the Am. Wood Preservers' Assn.

The Relation of Tie Renewals to Depreciation, S. S. Roberts. Ry. Maintenance Engr., vol. 16, no. 6, June 1920, pp. 222-224, 2 figs. Construction of depreciation curves.

RAILWAY OPERATION

Essential Services

Essential Services in Railway Operation and Control—II, J. A. Harris. Ry. Gaz., vol. 32, no. 20, May 14, 1920, pp. 725-728, 1 fig. Article is based on writer's experience as operating superintendent of South African Railway.

Freight-Train Loads

The Economics of the Freight Train Load, William J. Cunningham. New England Railroad Club, April 13, 1920, pp. 73-89 and (discussion), pp. 89-106. Theoretical manner of computing theoretical train load on grade of specified rate at specified speed under normal conditions for locomotive of given characteristics and train made up of cars of given average weight, is exemplified.

Joint Conference Railroad Bill

The Return of the Railroads to Corporate Management and Their Problems, Samuel O. Dunn. Jl. Western Soc. Engrs., vol. 25, no. 8, Apr. 20, 1920, pp. 253-266. General survey of conditions existing on railroads at present time and information as to precise provisions which the Joint Conference railroad bill contains, in regard to which writer claims there seems to be a great deal of misunderstanding.

Train Operation by Signals

Train Operation by Signal Indication—II, Henry M. Sperry. Ry. Age, vol. 65, no. 24, June 11, 1920, pp. 1669-1674, 6 figs. Comparative effectiveness of railway operation by train orders and by signal indication is discussed. Signal indication is preferred principally because necessary lapse of time between receipt and execution of train order is considered as element of weakness which does not exist in the case of operation by signals.

RAILWAY REPAIR SHOPS

Layout

Report of Committee on Repair Shop Layouts. Ry Age, Daily Edition, vol. 68, no. 24, June 15, 1920, pp. 1801-1806, 3 figs. Scheme recommended by Committee of Am. Railroad Assn., Mech. Section.

RAILWAY SIGNALING

France

Repetition of Road Signals on French Locomotives (Généralisation de la répétition des signaux sur les locomotives, en France). J. Trévières. Genie Civil, vol. 76, no. 17, Apr. 24, 1920 pp. 391-394, 3 figs. Augereau wireless outfit which operates danger whistle on locomotive. System has been adopted and extensively introduced in French State Railways.

Fog-Signaling

Fog-Signaling. L. Weissenbruch. Bul. Int. Ry. Assn., vol. 2, no. 4, Apr. 1920, pp. 173-203, 16 figs. Cab-signaling and automatic train stops on Belgian State Railways and elsewhere.

RAILWAY TRACK

Scales

See SCALES, Truck.

REACTORS

Voltage Stresses

Voltage Stresses in Reactors in Service, F. H. Kierstead and Royal Meeker. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 6, June 1920, pp. 552-554, 3 figs. Experimental data are presented together with physical explanation of phenomena revealed. It was found, in part, that steep waves may be produced by sudden drop in voltage caused by short-circuit and that resistance shunting of an inductance reduces voltage stresses caused by steep waves.

RECLAMATION

See IRRIGATION.

RECORDS

Filing and Indexing

Office Records—Their Filing and Indexing Irene Warren. Jl. Electricity, vol. 44, no. 11 June 1, 1920, pp. 563-564. Suggestions in regard to handling back files and follow-up systems for incoming and outgoing mail.

RECTIFIERS

Kenotron

Thermoelectric Emission and Its Applications: The Kenotron (L'émission thermo-électrique et ses applications: le kénotron), G Johannes. Revue générale de l'Électricité, vol. 7, no. 22, May 29, 1920, pp. 733-746, 19 figs Construction and operation of kenotron.

REFRACTORIES

Specific Heat

Specific Heat and Heat Conductivity of Refractories (Ueber spezifische Wärme und Wärmeleitfahgkeit feuerfester Erzeugnisse) Spechsaal, vol. 52, no. 51, Dec 18, 1920, pp. 499-501, 2 figs. Gives review of results of three different investigations. Results of experiments are said to show that specific heats of firebricks of different composition show only slight variation.

REFRIGERATING PLANTS

Insulation

Judicious Use of Heat Insulation, J. B. Williams. Ice & Refrigeration, vol. 58, no. 6, June 1920, pp. 339-342, 1 fig. Investment cost for additional insulation compared with cost for larger refrigerating machinery.

Largest in World

The World's Largest Freezer. Power Plant Eng., vol. 24, no. 11, June 1, 1920, pp. 549-554, 11 figs. New Armour & Co. plant with 750-ton refrigerating capacity and storage space for 42,000,000 lb. of meat.

Packing-House

Cooler, Warehouse and Office Buildings for Gunns Limited at West Toronto, Ont., J. B. Carswell. Contract Rec., vol. 34, no. 20, May 19, 1920, pp. 450-452, 2 figs. Design of refrigerating building with double framing to provide for cork insulation.

RESEARCH

England

Report of First Conference of Research Organizations. Department of Scientific and Industrial Research. C. R. O. no. 1, July 29, 1919, 30 pp. Means of coöperating of various research organizations in British industries discussed.

Report of Second Conference of Research Organizations. Department of Scientific and Industrial Research, C. R. O. no. 2, Dec. 12, 1919, 30 pp., 1 fig. Development of research work in British industries.

Post-War, Stimulation of

The Stimulation of Research After the War, R. A. Harper. Science, vol. 51, no. 1324, May 14, 1920, pp. 473-478. Scientists, it is said, should set an example of discriminating judgment and careful analysis of evidence against "evolutionary theories promulgated by visionary and ill-trained statesmen and politicians," by properly regulating and coördinating research so that each problem shall receive its fit proportion of attendance, and making provision in research for "that free and untrammeled environment where personal inclination and initiative are the major factors."

[See also NITROGEN, Fixation of.]

RESERVOIRS, WATER

Mechanics of

Application of the Principles of Images to a Water Reservoir (Application du principe des images aux chambres d'eau), C. Camichel. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 19, May 10, 1920, pp. 1106-1107. Experimental application of Lord Kelvin's principle to the distribution of velocities in a water reservoir.

[See also FLOW OF WATER.]

RIVERS

Improvement

Construction of Lock D, Cumberland River, Rufus W. Pafford. Military Engr., vol. 12, no. 61, Jan.-Feb. 1920, pp. 13-20 and 77 and (discussion) pp. 77-78. Details of design and construction of one of the six locks comprising project for improvement of that part of river from Nashville, Tenn., to mouth, called Lower Cumberland.

Mississippi, Mouth of

An Open Mouth for the Mississippi River, Allen E. Washburn. Proc. Louisiana Eng. Soc., vol. 6, no. 1, Feb. 1920, pp. 17-32 and (discussion) pp. 32-41. Survey of work done to maintain navigable entrance to New Orleans, and visualization of probable future developments.

RIVETED JOINTS

Design

The Design of Riveted Joints, James Montgomerie. Eng. & Indus. Management, vol. 3, no. 18, Apr. 29, 1920, pp. 547-548, 1 fig. Information based on experiments carried out at instance of Committee of Lloyd's Register of Shipping concerning physical qualities of riveted joints. Paper presented before Instn. Engrs. & Shipbuilders in Scotland.

RIVETING

Electric Machine for

The "Remca" Electric Riveting Machine. Eng., vol. 109, no. 2836, May 7, 1920, pp. 625-626, 6 figs. Patented machine manufactured by Mada Eng. Co., Ltd., Liverpool.

ROAD CONSTRUCTION

Personnel for

Training the Personnel for Highway Construction and Transport, Clyde Jennings. Automotive Industries, vol. 42, no. 21, May 20, 1920, pp. 1145-1147. Opinions expressed at joint educational conference at Washington, May 14 and 15.

ROADS

Design

Traffic Census as Basis for Road Design, W. A. McLean. Contract Rec., vol. 34, no. 23, June 9, 1920, pp. 544-546. Experiences in Ontario and Massachusetts.

Materials, Tests for

Road Materials. Report of Committee D-4 Annual Meeting. Am. Soc. Testing Matls., June 22-25, 1920, 44 pp., 2 figs. Tests are suggested for specific gravity of road oils, road tars, asphalt cements and soft tar pitches and for quantity of clay and silt in gravel for highway construction; also for proportions for concrete for highway construction.

ROADS, BITUMINOUS

Surfacing

Bituminous Surface Treatment, M. C. Welborn. Good Roads, vol. 19, no. 23, June 5, 1920, pp. 287-290. Practice of Texas State Highway Dept.

The Refinery Superintendent Says—

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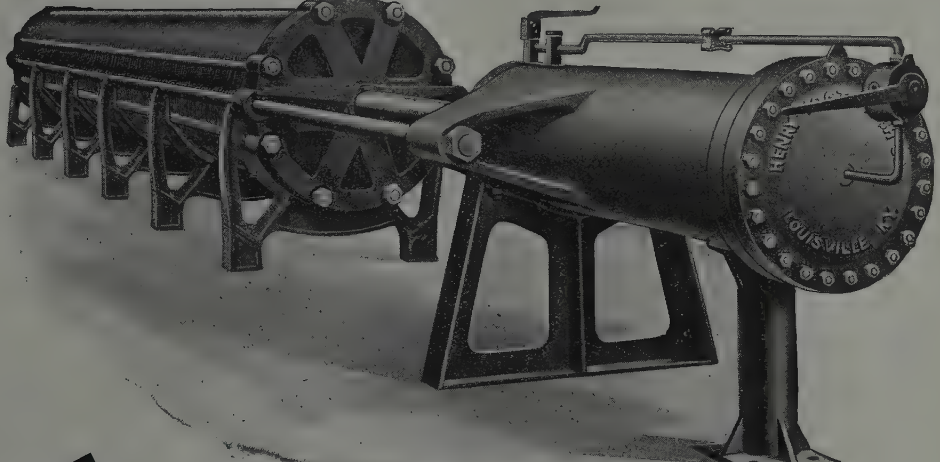

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ENGINEERING INDEX (Continued)

Warrenite-Bitulithic

History of Warrenite-Bitulithic Roads and Some Discoveries in Pavement Construction, George C. Warren. Contract Rec., vol. 34, no. 20, May 19, 1920, pp. 458-460. Notes on asbestos-bitulithic and double re-flushcoating are included.

ROADS, CONCRETE

Construction

Constructing a Concrete Road in Nebraska, A. S. Mirick. Public Works, vol. 48, no. 21, June 5, 1920, pp. 493-494. Round, water-worn gravel of feldspar and quartz, the only material available in the State, was tested for use as the concrete aggregate and was found to make stronger concrete than Potomac River gravel. It is now being used for six miles of the Lincoln Highway.

The Industrial Railway in Road Work. Good Roads, vol. 19, no. 17, Apr. 28, 1920, pp. 217-218, 2 figs. Equipment used by contractors in Illinois and Michigan in construction of concrete roads.

Developments

Recent Developments in Concrete Road Construction, A. N. Johnson. Eng. & Contracting, vol. 53, no. 18, May 5, 1920, pp. 514-518, 2 figs. Notes on subgrade, coarse aggregate tests and tests of sand for organic impurities, consistency, proportions for mixing concrete, etc. Gives Abrams tables of proportions and quantities for 1 cu.yd. of concrete, and instruction for practical application of table, and example of use of table. Abstract of paper presented before Am. Road Builders' Assn.

ROADS, EARTH

Maintenance

How to Improve and Maintain Earth, Clay and Sand Roads, A. R. Hirst. Can. Engr., vol. 38, no. 24, June 10, 1920, pp. 553-556. Experience of writer as highway engineer of state of Wisconsin.

ROCK DRILLS

Care of

Care of Rock Drills, Howard R. Drullard. Min. & Metallurgy, no. 162, June 1920, pp. 28-29, 1 fig. Suggestions in regard to lubrication of drills and method of forming drill shanks.

ROLLER CHAIN

Transmission

Roller-Chain for Tractors and Power Transmission. Am. Mach., vol. 52, no. 24, June 10, 1920, pp. 1223-1226, 12 figs. Manufacturing process of Spaulding Chain Co., Bloomfield, N. J.

ROLLING MILLS

Electrically Driven

Electric Mill Drives, J. D. Wright. Assn. of Iron & Steel Elec. Engrs., Jan. 1920, pp. 15-24, 6 figs. Discussion of electric mill drives with particular reference to some of factors which influence selection of electric equipment for driving main rolls of various types of mills. Information which is necessary for calculating proper size of motor required to roll any given product.

Electric Drive for Rolling Mill for Lead Sheets. Eng., vol. 109, no. 2824, Feb. 13, 1920, pp. 215 and 218, 4 figs. Equipment consists of 90-hp. mill motor, 75-kw. motor generator set with 2-ton flywheel and Ward-Leonard control gear.

The Krämer Three-Phase Regulating System for Electrically-Driven Rolling Mills and Mine Ventilators (Der Krämer-Drehstrom-Regelsatz in besonderer Ausführung für den Antrieb von Walzenstrassen und von Grubenventilatoren), E. Scherer. Elektrotechnik u. Maschinenbau, vol. 36, no. 12, Mar. 21, 1920, pp. 129-133 and (discussion) pp. 133-134, 8 figs. Paper read before Electrotechnical Soc. of Vienna.

The Largest Rolling Mill in the World. Elecn., vol. 84, no. 2190, May 7, 1920, pp. 519-521, 5 figs. Description and illustrations of a 20,500 hp. electrically-driven British 42-in. plate mill of reversing type, turning out plates at rate of 60 tons per hr. for two hrs. and at rate of 30 tons per hr. for remainder of shift. (To be concluded.)

Power Drives

Power Drives for Rolling Mills, W. O. Rogers. Power, vol. 51, no. 20, May 18, 1920, pp. 800-803, 6 figs. Various types of engine valves are treated as applying to rolling mill units. Reference is made to two large poppet-valve uniflow engines operating a 9- and 12-in. merchant mill. These engines operate with condensers and have disk-driven governors so designed that engine speed can be regulated while engine is in operation.

Screw-Down Motor Controllers

Control of Blooming Mill Tables and Screw-Downs, Walter C. Kennedy. Jl. Engrs. Club of Philadelphia, vol. 37-6, no. 187, June 1920, pp. 227. Design and characteristics of screw-down motor controllers.

Ship-Plate

The Dominion Iron and Steel Company's New Ship-Plate Rolling Mill, H. E. Rice. Iron & Steel of Canada, vol. 3, no. 4, May 1920, pp. 116-119, 3 figs. Latest type of mill erected at cost of $5,000,000 and put into operation Feb. 19, 1920.

ROPE DRIVE

Cotton Rope

Cotton Rope for Power Transmission, J. Melville Alison. Jl. Eng. Inst. of Canada, vol. 3, no. 6, June 1920, pp. 292-298, 10 figs. Discussing comparative advantages of cotton and manila rope, it is claimed, that although cotton is dearer than manila, "its superior resilience, grip and groove impact add so greatly to driving force that up to one-third more horsepower may be transmitted." It is stated that cotton has entirely supplanted any other material for transmission work in England. Table of horsepowers transmitted by three-strand cotton driving rope of various diameters is included.

RUBBER

Vulcanization of

The Acceleration of Vulcanization, D. F. Twiss and S. A. Brazier. Jl. Soc. Chem. Indus., vol. 39, no. 9, May 15, 1920, pp. 125T-132T, 10 figs. Experimental study of three methods: (1) raising temperature, (2) increasing proportion of sulphur relative to rubber, and (3) introducing accelerator.

RUBBER INDUSTRY

Electricity, Applications of

Electricity in the Rubber Industry, C. W. Drake. Can. Chem. Jl., vol. 4, no. 5, May 1920, pp. 133-135. Discusses high load and power factors for rubber plants.

RUST PREVENTION

See HOT-WATER SUPPLY.

S

SCAFFOLDS

See LADDERS.

SCALES

Track

A Track Scale With Many New Features. Ry. Maintenance Engr., vol. 16, no. 6, June 1920, pp. 229-231, 5 figs. Scales designed according to specifications adopted jointly by Am. Ry. Assn., Am. Ry. Eng. Assn., Railroad and Warehouse Comm. of Minn., Nat. Scale Men's Assn., Bur. of Standards, and Scale Manufacturers' Assn.

SCREW MACHINES

Cut-Off Cams for

Designing Cut-Off Cams for Automatic Screw Machines, John A. Crabtree. Machy. (N. Y.), vol. 26, no. 9, May 1920, pp. 806-807, 2 figs. Account of trouble experienced in cutting off work, cause of cut-off trouble and method of eliminating it.

SCREW THREADS

Measuring Instruments

Screw Thread Measuring Instruments — I. Eng. Production, vol. 1, no. 6, June, 1920, pp. 221-225, 13 figs. Machines designed by Metrology Department of National Physical Laboratory, England.

National Screw Thread Commission

National Screw Thread Commission Report. Mech. Eng., vol. 42, no. 6, June 1920, pp. 337-345. Commission is composed of engineers and government representatives, and was appointed by Act of Congress, July 16, 1918, to investigate and collate standards for screw threads to be adopted by manufacturing plants under the control of the Army and Navy, and also for adoption and use by the public. Report covers standards for threads and thread gages, including tolerances.

SEAPLANES

Commercial Types

The Ricci Commercial Seaplane R-I. Aviation, vol. 8, no. 9, June 1, 1920, pp. 365-366, 2 figs. Specifications: Span, upper and lower plane, 85 ft. 9 in.; overall length, 42 ft. 10 in.; maximum height, 13 ft. 10 in.; total wing area, 1,300 sq. ft.; weight loaded, 10,920 ft.; total hp., 660 hp.; max. horizontal speed, 100-110 m.p.h.; endurance, 4 hr.

Floats

The Gliding Surface of Seaplane Floats, A. Guidoni. Aviation, vol. 8, no. 9, June 1, 1920, pp. 363-365, 2 figs. Calculation is illustrated in case of cylindrical-float seaplane with separate gliding surface placed under floats.

[See also AEROPLANES, Load Factors; FLYING BOATS.]

SELENIUM

Illumination and Electrical Conductivity

On the Relation between Illumination and Electrical Conductivity in Selenium, A. O. Rankine. Lond., Edinburgh & Dublin Phil. Mag. & Jl. of Science, vol. 39, no. 233, May 1920, pp. 482-488, 2 figs. It is concluded from experiments with selenium cells that ultimate increase of conductivity of selenium is proportional to fourth root of light intensity.

SEPTIC TANKS

Hospital, India

Some Sanitary Installations, and an Experiment, in Patna, F. C. Temple. Indian Eng., vol. 68, no. 17, April 24, 1920, pp. 234-236, 3 figs. on 3 supp. plates. Septic tanks and filters for hospital.

SEWAGE DISPOSAL

Acid vs. Chlorine Process

Sewage Purification — Miles Acid System Compared with Chlorine Process. Public Works of the Navy, Under the Cognizance of the Bureau of Yards and Docks and the Corps of Civil Engineers, U. S. Navy, Bul. no. 31, Apr. 1920, pp. 84-93, 5 figs. Based on practice at U. S. Navy training camp.

Imhoff Tanks

Oriskany Builds New Sewerage System and Brick Imhoff Tanks, Charles M. Niles. Am. City (Town & County Edition), vol. 22, no. 5, May 1920, pp. 469-472, 3 figs. System installed in New York village having population of 1200.

Purification

A Process for the Purification and Deodorization of Sewage (Verfahren zur Reinigung und Geruchlosmachung schmutziger Abwässer). Zeitschrift fürr Transportwesen u. Strassenbau, vol. 36, no. 11, Apr. 10, 1919, pp. 124-125. Description of a purification process recently patented, in which the sewage is first treated with small quantities of chlorides or sulphates.

New Sewage Purification Plant (Eine neue Kläranlage). Zeitschrift für Transportwesen u. Strassenbau, vol. 36, no. 20, July 10, 1919, pp. 235-236, 1 fig. Description of a fresh-water settling tank (system OMS) of the German Purification Co., Wiesbaden, installed at a metalware factory in Mayence, which it is claimed can be maintained and operated at very little expense.

[See also SEPTIC TANKS.]

SHAFT SINKING

Quicksand

Shaft Sinking Through Quick Sand Under Heavy Pressure, L. Sauvestre. Colliery Guardian, vol. 99, no. 3100, May 28, 1920, pp. 1495-1497, 9 figs. Shafting was 622 m. deep and was sunk down to 500 m. by freezing process and lined with cast-iron tubbing, sinking being continued and shafts bricked. Translated from Annales des Mines de Belgique.

SHIP CONSTRUCTION

Alloy Steels, Use of

The Use of Stainless and Other Alloy Steels in Ship Construction, Leslie Aitchison. Eng. & Indus. Management, vol. 3, no. 18, Apr. 29, 1920, pp. 553-556. Author discusses problem of use of alloy steel for ship plates in all its aspects, and although he does not think it possible to use non-carbon steel for ship plates, he is of opinion that stainless steel can be used for many of smaller parts and components of ships, which he outlines.

Structural Steel Shapes for

Ship Construction Sections (Schiffbauprofile), J. Stieghorst. Schiffbau, vol. 21, nos. 13, 14 and 16, Feb. 18, 25 and Mar. 10, 1920, pp. 420-424, 442-447 and 491-495, 30 figs. Writer states that for walls requiring stiffening only, a simple angle is the most practical, while in other cases U-shaped sections are the most suitable. Description of section recommended by Dr. Rheder, which, it is claimed, is desirable for deck beams and bulkhead staying.

SHIPBUILDING

England

Notes on Our Economic Position as a Shipbuilding Country, Alfred Yarrow. Eng., vol. 109, no. 2831, Apr. 2, 1920, pp. 459-462, 4 figs.

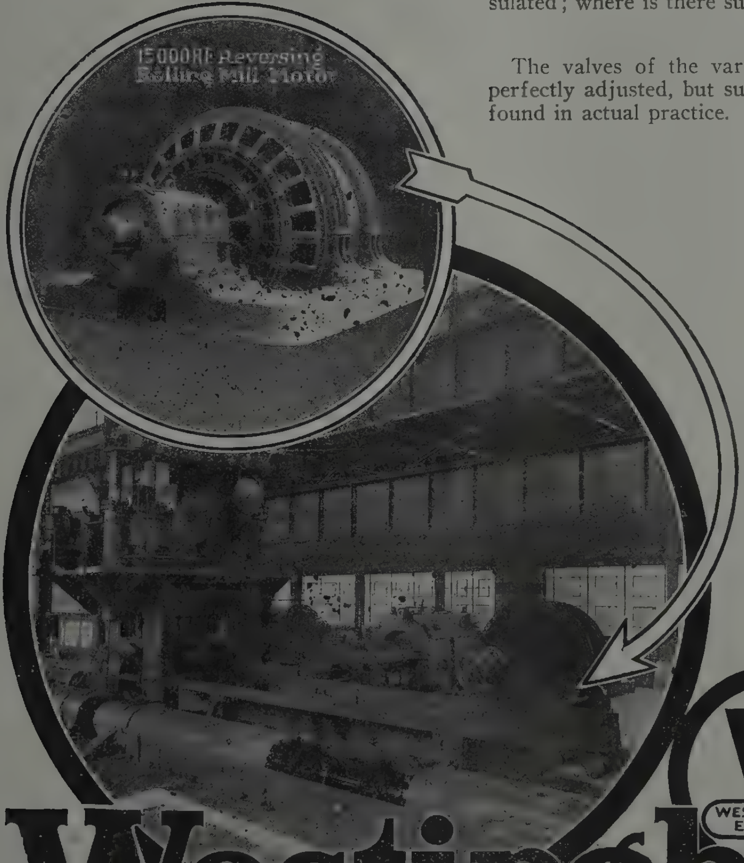
Human Nature—

At a recent meeting of the Assoc. of Iron & Steel Elec. Engrs. a prominent Pittsburgh Engineer touched a fundamental truth when he said:—

> " A great many things in steel mill operation are possible, but are highly improbable."

The statement followed a lengthy discussion during which steam drive was made to compare favorably with electric drive under ideal conditions of steam operation. And to make this point more clear, this engineer said further—

> " A steam or hydraulic lever can be worked as many times in a turn as the handle of a master controller; but it is seldom done.
>
> Long steam lines can be kept tight and thoroughly insulated; where is there such an example?
>
> The valves of the various driving engines can be kept perfectly adjusted, but such conditions are seldom, if ever, found in actual practice.
>
> Roll pass design and friction loads can be studied by means of steam flow meters and indicator cards, but is such practice universal?
>
> In all of the above, the electric drive is so simple that the corresponding points are looked after with a resultant saving over actual steam drive practice."



Westinghouse Electric & Manufacturing Co.
EAST PITTSBURGH, PA.

Westinghouse

ENGINEERING INDEX (Continued)

Paper read before Instn. of Naval Architects, England.

Production Systems

Production Methods in Shipbuilding—I, William B. Ferguson. Indus. Management, vol. 59, no. 6, June 1920, pp. 439-443, 1 fig. Relation of supervision to planning and scheduling is taken up, and organization of shipyard is discussed with particular reference to functions of manager and his staff.

SHIPPING

See MERCHANT MARINE.

SHIPS

Cargo

Notes on the Dimensions of Cargo Steamers, John Anderson. Int. Mar. Eng., vol. 25, no. 6, June 1920, pp. 496-499, 4 figs. Discusses best proportions of depth and breadth for lengths obtained under different conditions of loading and length of voyage. Paper read before Instn. Naval Architects.

Cargo, Machinery for

Installing Machinery and Operation of 7825 D. W. T. Cargo Carriers, C. S. Bookwalter. Jl. Engrs. Club of Philadelphia, vol. 37-6, no. 187, June 1920, pp. 241-245, 4 figs. Operations required for properly lining turbines and reduction gears and shafting.

Design

Freeboard and Strength of Ships, J. Bruhn. Int. Mar. Eng., vol. 25, no. 6, June 1920, pp. 500-503, 1 fig. Examination of existing rules and practices of various countries regarding freeboard and strength of ships. Considerations towards establishment of international rules. Paper read before Instn. Naval Architects.

Engineering Equipment

Present-Day Marine Engineering Equipment, John C. McKenzie. Int. Mar. Eng., vol. 25, no. 6, June 1920, pp. 511-512. Compares efficiencies of stationary power plant and marine power plant. Great efficiency of former is attributed to better utilization of modern equipment in it.

Funnels, Air Pressure About

The Distribution of Air Pressure and Wind Velocity About the Funnel of a Vessel at Sea, A. P. Thurston. Eng., vol. 109, no. 2822, Jan. 30, 1920, pp. 134-135, 4 figs. Results of experiments.

Hull Structure, Testing

Testing the Hull Structure of Ships, F. K. Ruprecht. Int. Mar. Eng., vol. 25, no. 6, June 1920, pp. 519-521. Test schedule for cargo vessels. Rules and methods for testing peak and ballast tanks and forward collision bulkhead. (To be continued.)

Stabilization by Gyroscopes

The Stabilization of Ships by Means of Gyroscopes, P. R. Jackson. Eng., vol. 109, no. 2831, Apr. 2, 1920, pp. 462-464, 8 figs. Principles of stabilizing by gyroscope system with mechanical details of its application to ships. Paper read before Instn. Naval Architects.

Ventilation of

Ship Ventilation, F. R. Still. Jl. of Am. Soc. of Heat. & Vent. Engrs., vol. 26, no. 3, Apr. 1920, pp. 363-376, 13 figs. Survey of practices of typical ships of various classes.

[See also LIFEBOATS.]

SHIPS, CONCRETE

Barges

The First Reinforced-Concrete Ship in Hungary (Das erste Eisenbetonschiff in Ungarn). Gerhard Neumann. Beton u. Eisen, vol. 19, no. 1, Jan. 8, 1920, pp. 7-10, 10 figs. Details and illustrations of design and construction of Danube River barge with a displacement of 350 tons at 1.9-m. draft and 500 tons at 2.3-m. draft; overall length of 53.1 m. and width of 8.2 m.

SHIPYARDS

Armstrong, British

The Armstrong Shipyard. Eng., vol. 109, nos. 2829, 2831, 2832, 2834 and 2836, Mar. 19, Apr. 2, 9, 23, May 7, 1920, pp. 366-370, 14 figs. partly on supp. plate, pp. 434-437, 34 figs., pp. 469-472, 17 figs. partly on supp. plate, pp. 540-543, 11 figs., partly on four supp. plates, pp. 601-603, 4 figs. Description of 1000-ft. shipbuilding berth. Details of reinforced-concrete portion of jetty between two largest building berths. Jetty is 350 ft. long and 30 ft. wide at deck level. Details of reinforced-concrete structures designed on Hennebique system. Plan and details of platers' shed. Details of anglesmiths' shop. (Continuation of serial.)

Electric Drive for Machinery

Electric Motors for Shipyard Machinery, William Harrison, James Goldsborough and William H. Easton. Int. Mar. Eng., vol. 25, no. 6, June 1920, pp. 469-475, 11 figs. Circumstances governing choice of motor are discussed and comparative advantages of individual and group drive are pointed out.

Furness, British

The New Furness Shipbuilding Yard at Haverton Hill-on-Tees. Shipbuilder, vol. 22, no. 118, June 1920, pp. 421-437, 14 figs. Total area of shipyard is about 85 acres and total river frontage about 2500 ft. All machinery throughout yard is driven by electrical power.

SHOP COMMITTEES

Coöperation with Unions

Shop Committee Development Possible in Unionized Plant, Harry Tipper. Automotive Industries, vol. 42, no. 22, May 27, 1920, pp. 1224-1225. Successful development of shop committee in an English plant is quoted as showing possibilities of organizing shop committees in coöperation with unions.

SILVER METALLURGY

Cyanide Plant

A Cyanide Plant Without Frills, Leroy A. Palmer, Eng. & Min. Jl., vol. 109, no. 23, June 5, 1920, pp. 1260-1262, 1 fig. Mill built for treating 200,000 tons of silver tailings at Calico, Cal.

SLAG

Blast-Furnace

Blast Furnace Slag in the Building Industry (Hochofenschlacke im Baugewerbe), A. Moye. Tonindustrie-Zeitung, vol. 43, no. 153, Dec. 30, 1919, pp. 1380-1381. Review of a book entitled The Use of Blast Furnace Slag in the Building Industry, by A. Guttmann, which is a summary of numerous publications, the source of all information being given in a bibliography appended to work.

Methods of Grinding

Slag Mills (Schlackenmühlen), Hubert Hermanns. Annalen für Gewerbe u. Bauwesen, vol. 85, nos. 11 and 12, Dec. 1 and 15, 1919, pp. 85-89 and 93-98, 34 figs. Describes two methods of grinding the phosphoric-acid-bearing slag for fertilizer purposes, the double-mill and single-mill. Details and illustrations of equipment used in connection with slag grinding and investigation of operation, products and practice of various steelwork plants. Address delivered before Soc. German Machine Engrs.

SMOKE PREVENTION

Hemmann Apparatus

The Hemmann Smoke and Soot-Prevention Apparatus (Rauch- und Russverhütungsapparat), A. Reich. Gesundheits-Ingenieur, vol. 43, no. 5, Jan. 31, 1920, pp. 54-55. Description of apparatus said to have been in satisfactory operation since February, 1919.

SNOW

Crystals

Snow crystals from the Crystallographic Standpoint, Edgar T. Wherry. Monthly Weather Rev., vol. 48, no. 1, Jan. 1920, pp. 29-31, 32 figs. Photographs are presented which are believed to confirm view that ice is ditrigonal-hyramidal in crystallization.

SNOW PLOWS

Rotary

Development of Snow Fighting Equipment, W. A. Winterrowd. Ry. Age (Daily Edition), vol. 68, no. 24a, June 11, 1920, pp. 1722-1726, 5 figs. Canadian Pacific heavy rotary plow.

SNOW REMOVAL

Highways

New Method of Snow Removal. Can. Engr., vol. 38, no. 19, May 6, 1920, pp. 437-438, 3 figs. Christie four-wheel-drive truck equipped with bucket-type conveyor driven by Sterling engine.

SPRINGS

Laminated

Design of Laminated Springs, S. H. Jenkinson. New Zealand Jl. of Sci. & Technology, vol. 3, no. 1, Feb. 1920, pp. 16-25, 6 figs. Formulæ are developed for computing dimensions in terms of required strength and flexibility. It is figured out mathematically that spring of maximum strength and flexibility would be obtained by making each leaf full length and tapering each one for whole length of cantilever. Such spring, however, would cut into much more steel and would offer no advantages.

STEAM

Alignment Diagram

A Steam Alignment Diagram, D. Halton Thomson. Eng., vol. 109, no. 2827, Mar. 5, 1920, pp. 301-305, 10 figs. Based on equations for properties of steam propounded by Prof. H. L. Callendar.

STEAM ENGINES

Experimental

Experimental Engine at University College, Cardiff. Eng., vol. 109, no. 2836, May 7, 1920, pp. 612-614 and 616, 10 figs. Horizontal compound with cylinders arranged side by side.

Reversing

An Auxiliary Steam Cylinder for Reversing Engines (Hilfsdampfzylinder für Umkehrmaschinen), F. Förster. Dinglers polytechnisches Jl., vol. 335, no. 1, Jan. 10, 1920, pp. 1-3, 4 figs. Description of a reversing apparatus of recent design without oil cataract cylinder for winding and rolling-mill engines, which is said to be simple and inexpensive and can be employed in older plants. Other uses of apparatus are referred to.

STEAM POWER PLANTS

Auxiliaries

Electric Drive for Station Auxiliaries, E. E. George. Elec. World, vol. 75, no. 24, June 12, 1920, pp. 1365-1366. Motors operated with steam diverted from intermediate stage of turbines for feedwater heating are said to be more economical than steam-driven auxiliaries.

Costs

Power Costs During Years 1914 to 1919, Hubert E. Collins. Indus. Management, vol. 59, no. 6, June 1920, pp. 467-472, 1 fig. Summary of records of 14 representative plants. Conditions that prevailed in plants are surveyed, noting changes in power costs that took place during the years of the war. Tables of costs of heating industrial buildings, distribution of power consumption between various departments of industrial plants, and costs of softening boiler feed water using lime and soda ash, are given.

STEAM TURBINES

Centrifugal Testing Plants

Centrifugal Testing Plants for High-Speed Machine Parts (Schleuderanlagen für rasch umlaufende Maschinenteile). Zeitschrift für das gesamte Turbinewesen, vol. 16, no. 35, Dec. 20, 1919, pp. 383-384, 2 figs. Description and illustrations of two centrifugal testing pits in the works of the Brown Boveri Co., Baden, for horizontal and vertical turbine and blower rotors.

Geared, Lubricating System for

Lubricating System for Geared Turbines, J. Emile Schmeltzer and B. G. Fernald. Int. Mar. Eng., vol. 25, no. 6, June, 1920, pp. 508-510, 1 fig. Standard oiling system developed by Emergency Fleet Corporation for adoption on vessels equipped with geared turbines. Paper read before Soc. of Nav. Architects and Mar. Engrs.

STEEL

Galvanized, Strength of

Metallographical Study on Galvanized Steel, Y. Taji. Eng., vol. 109, no. 2827, Mar. 5, 1920, pp. 327-329, 19 figs. Results of experiments. Of special interest were values found for alternating strength of steel bar both before and after galvanization, which were 25.2 and 24 tons per sq. in. respectively. Paper read before Soc. of Naval Architects, Japan.

Nitrogen in

Nitrogen in Steel, and the Erosion of Guns, H. E. Wheeler. Min. & Metallurgy, no. 160, April 1920, p. 32. Experiments conducted at testing laboratory of Watertown Arsenal.

Sulphur and Phosphorus in

Sulphur and Phosphorus in Steel, E. E. Thun. Jl. Am. Steel Treaters Soc., vol. 2, no. 8, May 1920, pp. 368-391. Survey of technical literature on effect of sulphur and phosphorus on quality of steel. Outline of tests to be conducted by representative committee appointed upon initiative of Am. Soc. for Testing Materials, U. S. Railroad Administration and Bur. of Standards for investigation of problem.

Metallurgical Theories Conflict. Foundry, vol. 48, no. 12, June 15, 1920, pp. 467-468 and p. 495. Bibliography on effect of phosphorus and sulphur in steel compiled by joint committee of several technical societies.

The Distribution of Phosphorus in Steel Between the Points AC1 and AC3, J. H. Whiteley. Iron & Steel Inst., Paper 9, Annual Meeting, May 6 & 7, 1920, 24 pp. 24 figs. Steels in which phosphorus varied from 0.006

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HEADQUARTERS

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The Sinclair Refineries, from which come the famous Sinco Products, are noted for their highly efficient operation. At the Vinita, Oklahoma, refinery of this company, seventeen boilers were found unable to produce sufficient steam for existing needs. But a wise executive suggested that, before the purchase of additional boilers be considered, a water softener be installed to increase the efficiency of the boilers already erected.

This done, it was not only found unnecessary to install additional boilers, with the water softener in operation, but it became possible to *reduce the number of boilers in operation from seventeen to twelve, and at the same time produce a greater amount of steam.* Those seventeen boilers, while they were using hard water, were constantly accumulating "boiler scale," which acted as insulation against the heat applied, lessening both the efficiency and the capacity of the boilers. This scale, furthermore, ran up the fuel consumption to an extravagant point, and necessitated the frequent withdrawal of boilers from service for cleaning and repair.

Today, most of the great American railroads soften water for their locomotive boiler supply, and a large number of stationary boiler users, textile mills, ice manufacturers, laundries, hotels, etc., are using water softeners.

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to 0.12 per cent were heated to and maintained at temperatures between critical points Ac1 and Ac3. Part of phosphorus contained in Y-iron diffused into adjacent ferrite. At temperatures below 650 deg. cent. phosphorus diffused extremely slowly in ferrite; above this temperature, velocity gradually increasd, and above 800 deg. cent. it was rapid. Velocity of diffusion of phosphorus in Y-iron also increased with temperature.

[See also CHROMIUM STEEL; CHROME-NICKEL STEEL; NICKEL STEEL.]

STEEL CASTINGS

Design

Practical Notes on the Design and Treatment of Steel Castings, George F. Preston. Iron & Steel Inst., Paper 7, Annual Meeting, May 6 & 7, 1920, 12 pp. 9 figs. Suggestions to designers of castings.

STEEL, HEAT TREATMENT OF

Ball Bearings

The Heat Treatment of Ball Bearing Steel, Carl T. Hewitt. Jl. Am. Steel Treaters Soc. vol. 2, no. 8, May 1920, pp. 395-399, 5 figs. Practice at plant of Fafnir Bearing Co.

Brazed Fittings for Aircraft

Heat-Treating of Brazed Fittings for Aircraft, Archibald Black. Am. Mach., vol. 52, no. 23, June 3, 1920, pp. 1184-1186, 4 figs. Includes typical list of steels used in aircraft work with their approximate properties.

Quenching Baths

Fuels, Burners and Quenching Mediums for Heat-Treatment, S. P. Rockwell. Machy. (N. Y.), vol. 26, no. 9, May 1920, pp. 837-840, 5 figs. Points out advantages and disadvantages of different kinds of fuel and types of burners, and gives description of results obtained by various quenching baths.

Tool Hardening

Some General Principles of Tool Hardening, A. E. Bellis. Jl. Am. Steel Treaters Soc., vol. 2, no. 8, May 1920, pp. 364-367. Emphasizes that practical means of controlling results from foundry, through, rolling, annealing, forging, and hardening, is to maintain uniformity of composition and uniformity of heat treatment.

STEEL, HIGH-SPEED

Hardening and Tempering

Note on the Structural Constitution, Hardening, and Tempering of High-Speed Steel Containing Chromium and Tungsten, Kotaro Honda and Takejior Murakami. Iron & Steel Inst., Paper 15, Annual Meeting, May 6 & 7, 1920, 11 pp. It is concluded from experimental analysis that in annealed state, high-speed steel containing about 5 per cent chromium, 18 per cent tungsten and 0.6 per cent carbon consists of iron dissolving tungstide, free tungstide and carbides, Cr4C and WC, in free state. Tungsten, it is said, lowers maximum temperature at which, during cooling, self-hardening property of steels begins to take place. Abstract from 32nd Report of Iron & Steel Research Inst. of Japan.

Testing

A Comparative Test of High-Speed Steels, A. J. Langhammer. Am. Mach., vol. 52, nos. 19, 22 and 24, May 6 and 27 and June 10, 1920, pp. 979-982, 1140-1143, 4 figs, and 1227-1230. Method of procedure in testing sixteen different commercial brands of high-speed tool steel, together with data as to performance of each individual tool, its chemical composition, heat treatment, and hardness.

A Comparative Test Upon High-Speed Steels—IV, A. L. Langhammer. Chem. & Metallurgical Eng., vol. 22, no. 21, May 26, 1920, pp. 969-975, 18 figs. It is concluded from tests that chemical analysis of high-speed steel may be used only as indicator of its possible qualities. It is advised that in conducting a test no less than four specimen tools should be used, and in order to get most efficient results from high-speed steel tools they must be operated under heavy duty.

STEEL MANUFACTURE

Automobile Steels

The Essentials of High-Grade Steel Manufacture, W. R. Shimer. Jl. Soc. Automotive Engrs., vol. 6, no. 6, June 1920, pp. 387-393. Selection of raw materials.

Electric-Furnace

The Manufacture of Steel in the Electric Arc Furnace (Le four à arc pour la fabrication de l'acier), H. Verdinne. Revue universelle des Mines, vol. 5, no. 2, April 15, 1920, pp. 107-132. Economical advantages. (Concluded.)

Open-Hearth Process

Notes on Slag Conditions in Open-Hearth Basic Steel-Making Practice, Jno. F. Wilson. Iron & Steel Inst., Paper 10, Annual Meeting, May 6 & 7, 1920, 22 pp. 3 figs. Opinion is expressed that in fluid state, slags cannot contain any "free acids" or "free bases," and can be viewed as solution of different chemical compounds in one another. "Free acids" or "free bases," by themselves, it is said, demand higher temperatures to bring them to a molten condition than is usually attained by steel furnace slag.

The Reduction of Silicon from the Slag in the Acid Open-Hearth Process, B. Yaneske and G. A. Wood. Iron & Steel Inst., Paper 12, Annual Meeting, May 6 & 7, 1920, 20 pp. 2 figs. Five examples of finished steels which were found to contain much higher percentage of silicon than was expected from finishing additions, are described.

STEEL WORKS

Electrically Driven

Direct Current Compared with Three-Phase Current for Driving Steelworks Plant, C. A. Ablett. Iron & Steel Inst., Paper, Annual Meeting, May 6 & 7, 1920, 17 pp. 2 figs. Direct-current motors are preferred because they are capable of speed variation over wide range without loss of power, while three-phase motors are not capable of such variation without considerable loss of power unless they are of complicated and costly type, "and therefore not well suited to many steel works purposes."

Lorraine, France

Lorraine Steel Works in French Hands. Machy. (London), vol. 105, no. 15, April 8, 1920, pp. 1023-1024 and 1039. Abstract of report of trade commissioner J. F. Butler sent from Paris to Bureau of Foreign & Domestic Commerce at Washington, giving account of extent of industry in annexed territory, difficulties with labor under new ownership, etc. Output is said to be only one-third of normal.

Machinery, French Works

Machinery at the Steel Works of the Société Normande de Métallurgie, Caen, France. Eng., vol. 109, no. 2826, Feb 27, 1920, pp. 284 and 293-294, 24 figs. partly on 4 supp. plates. Metal mixer, ladle cranes, soaking pits, and billet-handling cranes. (Concluded.)

Repair Shops

Steel Mill Electrical Repair Shop Practice, A. J. Standing. Assn. of Iron & Steel Elec. Engrs., April 1920, pp. 19-28 and (discussion) pp. 28-45. Writer claims as most plants are rather spread out, it is necessary to decide on one or two definite policies; first, the use of one large central repair shop to which all damaged apparatus is sent for repairs, or second, the use of a somewhat smaller central repair shop, together with several small local repair shops in isolated parts of mill. Recommends electrical storeroom in conjunction with shop, and discusses correlation between construction and maintenance, etc.

STOKERS

Fuel-Blending

Nicol-Schofield Stoker for Blended Fuels (Appareils de chauffe mécanique à plusieurs combustibles, système Nicol et Schofield). Génie Civil, vol. 76, no. 18, May 1, 1920, pp. 411-413, 4 figs. Two layers of coke and coal are fed simultaneously into furnace. Coal layer is on top. Each fuel is kept in separate pit.

STREET RAILWAYS

Boston

Boston—and Her Trolley Cars, Edward Hungerford. Elec. Ry. Jl., vol. 55, no. 21, May 22, 1920, pp. 1032-1037, 9 figs. How complications arising from narrow streets and topographical peculiarities of cities have been overcome. Rising tide of expenses, which threatened financial embarrassment of company, determined State to take over operation of property guaranteeing fixed return to stockholders and to raise fare to ten cents.

Financing

The Equipment Trust Grows in Favor. Elec. Ry. Jl., vol. 55, no. 21, May 22, 1920, pp. 1047-1059, 3 figs. Instances are quoted of equipment for street railways being owned by local banks and leased to company. Such practice is said to be growing in favor and outlines are suggested for standardizing this method of purchasing rolling stock.

Rails, French Standard

Use of Light Tramway Cars in France. Tramway and Ry. World, vol. 47, no. 24, May 13, 1920, pp. 249-250, 6 figs. Proposed design of French standard tramway rails is included.

STRIKES

Law Governing

The Law and the Labor Unions, Kenneth M. Spence. Indus. Management, vol. 59, no. 6, June 1920, pp. 433-438. Exposition of law governing coal, railroad and other strikes. Rights and limitations of employees to strike and of employers to close their plants and cease to do business, are explained. It is demonstrated how certain rights that belong to an individual do not belong to a combination of individuals. Theory is advocated that disputes in industry should be determined on a broader basis than mere law, by applying social and economic principles.

STRUCTURAL STEEL

Preservative Coatings for

Report of Committee D-1, Annual Meeting, Am. Soc. Testing Matls., June 22-25, 1920, 32 pp., 4 figs. Theory of preservative coatings for structural materials. Tentative specifications for turpentine.

SUBMARINES

German

German Submarines, A. W. Johns. Eng., vol. 109, no. 2830, March 26, 1920, pp. 428-432, 9 figs. Information as to types, number, cost and other particulars.

SUGAR

Analysis

The Double-Polarization Method for Estimation of Sucrose and the Evaluation of the Clarget Divisor, Richard F. Jackson and Clara L. Gillis. Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 375, March 30, 1920, pp. 125-194, 2 figs. Velocity of inversion of sucrose was measured at temperatures from 20 to 90 deg. cent. and was found to follow exponential law proposed by Arrhenius. Rates of reaction were measured for three different concentrations of hydrochloric acid. Time required under different conditions to produce 99.99 per cent inversion is computed and tabulated.

T

TANK STEAMERS

Large

Oil Tank Steamer San Fernando, F. C. Coleman. Int. Mar. Eng., vol. 25, no. 6, June, 1920, pp. 484-488, 3 figs. Largest of new fleet of 18,000-ton steamers building for Eagle Oil Transport Co., Ltd. Dimensions: Length overall, 547 ft.; breadth, molded, 69 ft.; depth, molded, 42 ft.; extreme draught of water, 30 ft.

Tank Steamer of 12,620 Tons Deadweight. Int. Mar. Eng., vol. 25, no. 6, June, 1920, pp. 476-478, 4 figs. partly on supp. plate. Type of vessel built for Standard Transportation Company at the Fore River plant of Bethlehem Shipbuilding Corporation, Ltd.

TAPPING MACHINES

Multiple-Spindle

Foote-Burt "Way" Tapping Machines, J. V. Hunter. Am. Mach., vol. 52, no. 19, May 6, 1920, pp. 975-977, 6 figs. Multiple-spindle machine for tapping many holes simultaneously.

TELEGRAPH LINES

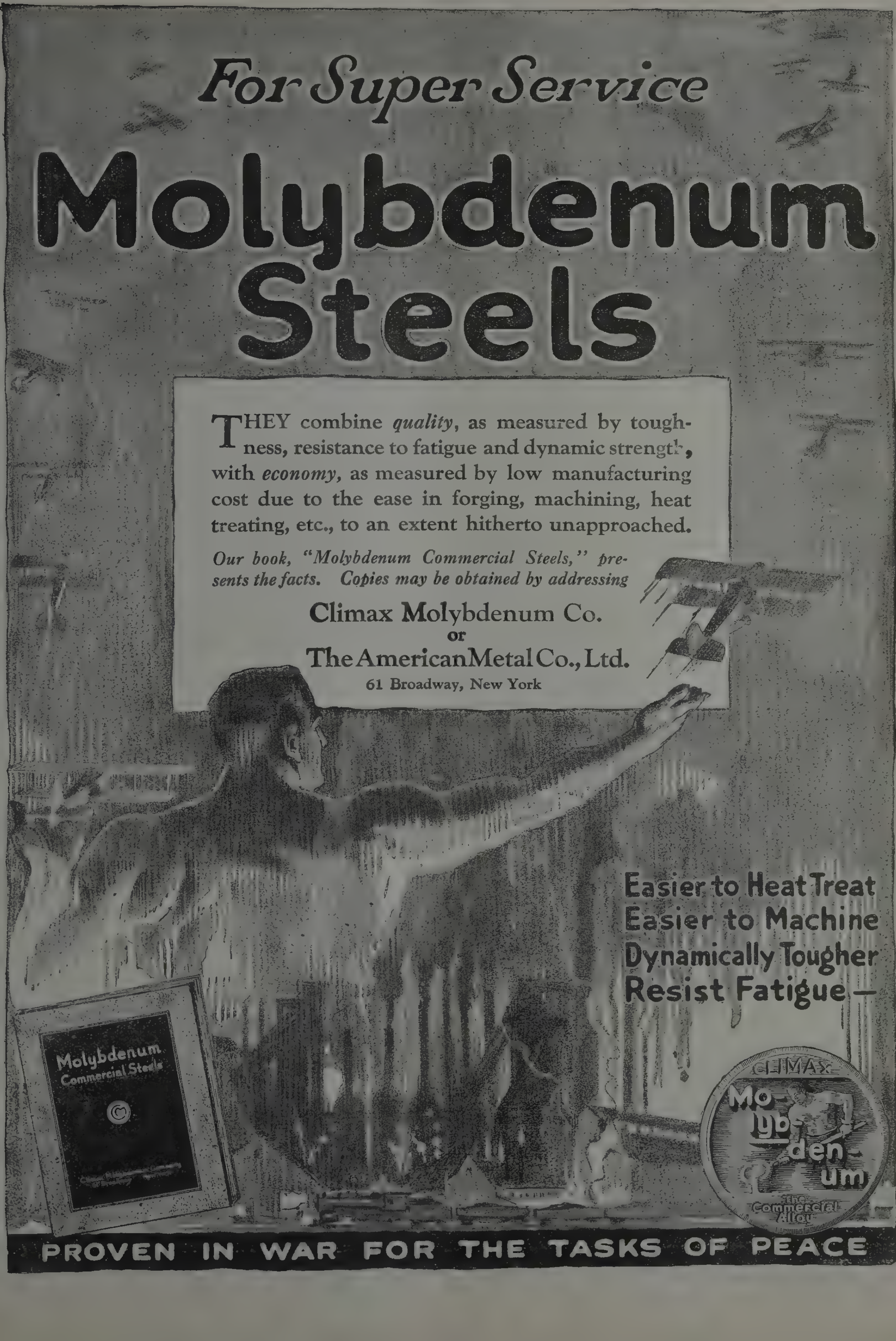
England

Underground and Submarine Telegraph Lines in England (Lignes télégraphiques souterraines et sous-marines en Angleterre), M. Ballet. Annales des Postes, Télégraphes et Téléphones, vol. 9, no. 1, March 1920, pp. 37-67, 23 figs. Operation is duplex, differential or Wheatstone bridge. Types of installation generally used are quadruple duplex Baudot and double duplex Baudot. Schemes of connections are indicated and operation studied.

TELEGRAPHY

Multiplex

The Siemens Rapid Telegraph Apparatus (Zur Einführung des Siemens-Schnelltelegraphen), George Schmidt. Dinglers polytechnisches Jl., vol. 335, no. 4, Feb. 21, 1920, pp. 41-43, 6 figs. Description of apparatus designed by Wilhelm v. Siemens which, similar to the Daubot system employs for every character five current impulses in positive and negative direction in certain given combinations, by which 32 combinations can be formed. Apparatus requires for each station three or four keyboard instruments for perforating the sending tapes, a sender and a receiver apparatus. See also Prometheus, vol. 31, no. 15, Jan. 10, 1920, pp. 113-116, 3 figs.



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ENGINEERING INDEX (Continued)

TELEPHONY

Automatic

Machine Switching, E. B. Craft. Telegraph & Telephone Age, vol. 38, no. 10, May 16, 1920, pp. 276-282, 14 figs. Apparatus for automatic telephony developed by Western Electric Co.

Secret

Amplifiers for a Secret Telephone (Un téléphone secret par amplificateurs), P. Maurer. Électricien, vol. 35, no. 1252, May 15, 1920, pp. 199-201, 3 figs. System used by French Army during war.

TERMINALS, RAILWAY

Freight

The Liverpool Goods Stations of the Lancashire & Yorkshire Railway. Ry. Gaz., vol. 32, no. 22, May 28, 1920, pp. 796-801, 11 figs. Equipment includes two 1½-ton and one ¾-ton electric overhead cranes.

TESTING MACHINES

Repeated-Stress

A New Repeated-Stress Testing Machine, Jesse B. Dommers. Wisconsin Engr., vol. 24, no. 8, May 1920, pp. 297-299, 1 fig. Machine designed and used by writer at research laboratory of University of Illinois.

THERMODYNAMICS

New Cycle

A New Thermodynamic Cycle, William J. Walker. Eng., vol. 109, no. 2852, Apr. 9, 1920, p. 467, 1 fig. "Dual combustion cycle" in which heat is imparted to working fluid by internal combustion both at constant volume and constant pressure.

TIDAL POWER

Stations

The Theory of Tidal Power Stations, P. Caufourier. Engr., vol. 129, no. 3354, Apr. 9, 1920, pp. 372-373, 7 figs. Diagram of mean effective power computed for following data: Area of basin, 1,000,000 sq.m.; section of sluice, 5.85 sq.m.; half-amplitude of tide, 2 m. at neap tide. Translated from Génie Civil.

TILE

Drain

An Investigation of Tests of Iowa Shale Drain Tile, W. J. Schlick. Official Publication of Iowa State College of Agriculture and Mechanic Arts, vol. 16, no. 43, Mar. 27, 1918, 71 pp. 18 figs. Method is recommended for conducting sodium sulphate tests which is said to have been found quicker, more convenient and more economical than any of freezing and thawing tests or other sulphate tests described. Method is believed to be well adapted for use by tile manufacturer as rapid approximate determination of whether his products will successfully pass Am. Soc. for Testing Materials standard freezing and thawing requirements for drain tile.

TIME STUDY

Job Analysis

Time and Job Analysis in Management—III, William O. Lichtner. Indus. Management, vol. 59, no. 6, June 1920, pp. 487-491, 6 figs. How to prepare ground for analysis by winning over superintendent, showing how to talk to foremen and outlining relationship between analyst and everyone with whom he comes in contact during his work.

TIN

Separation from Antimony

Separation of Tin from Antimony. Treatment of Tin by Cupferron (Séparation de l'étain et de l'antimoine. Dosage de l'étain par le cupferron), A. Kling and A. Lassieur. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 19, May 10, 1920, pp. 1112-1114. Successful experiments are reported with use of sulphuretted hydrogen in a hydrofluoric medium.

TITANIUM

Uses

Industrial Uses of Titanium (Note sur les usages industriels du titane), M. F. Bertrand. Revue universelle des Mines, vol. 5, no. 2, Apr. 15, 1920, pp. 139-155, 7 figs. Comparative analyses of ferrotitanium and ferrocarbotitanium are included.

TOOL MAKING

See STEEL, HEAT TREATMENT OF, Tool Hardening.

TOWN PLANNING

Montreal

Replanning Montreal and District, James Eqing. Jl. Eng. Inst. of Canada, vol. 3, no. 6, June 1920, pp. 283-288. Financial advantages derived from good city planning are pointed out. As example of disadvantages of not possessing carefully laid plan, case of Montreal is quoted.

TRACTOR ENGINES

Motor Boats, Adapting to

Adapting Truck and Tractor Engines to Motor-Boat Use, Joseph Van Blerck. Jl. Soc. Automotive Engrs., vol. 6, no. 6, June 1920, pp. 378-380, 5 figs. Method of Wellman-Seaver-Morgan Co., Akron, Ohio.

Rating

Tractor Standardization and Rating, Oliver B. Zimmerman. Wisconsin Engr., vol. 24, no. 8, May 1920, pp. 307-309. Formula is suggested for rating kerosene-burning tractor engines.

TRACTORS

Camshafts

Machining Tractor Camshafts, Ralph E. Flanders. Machy. (N. Y.), vol. 26, no. 9, May 1920, pp. 825-827, 6 figs. Description of equipment for milling, centering, turning and facing operations.

TRANSFORMERS

Oils for

Specifications for Transformer Oils (Cahier des charges pour la fourniture des huiles de transformateurs). Revue générale de l'Électricité, vol. 7, no. 22, May 29, 1920, pp. 727-733, 8 figs. Established by Technical Committee of Syndical Chamber of Constructors of Heavy Electrical Material.

Overload Protector

The Alternating-current Network Protector, H. C. Stewart. Gen. Elec. Rev., vol. 23, no. 5, May 1920, pp. 427-428, 2 figs. Device for protecting network against overload resulting from internal failure in transformer.

Voltage Diagrams

Fundamental Principles of Polarity, Phase Rotation and Voltage Diagrams of Transformers, A. Boyajian. Gen. Elec. Rev., vol. 23, no. 5, May 1920, pp. 374-385, 26 figs. Fundamental principles first as applied to single-phase circuits and then to three-phase circuits. Their bearing on parallel operation is discussed and practical problems are solved.

TRAWLERS

Electrically Operated

The Mariner: The First Electrically Operated Trawler, John Liston. Gen. Elec. Rev., vol. 23, no. 5, May, 1920, pp. 455-463, 17 figs. Characteristics: Length overall, 150 ft.; beam, 24 ft. 3 in.; mean draught, 11 ft. 9 in.; displacement, 500 tons. Propelling equipment comprises two eight-cylinder, four-cycle, 350-r.p.m. Diesel engines, each direct-connected to 165-kw., 125-volt, direct-current generator.

TUBES

Brass, Seamless

Making Seamless Brass Tubes, Otis Allen Kenyon. Iron Age, vol. 105, no. 16, April 15, 1920, pp. 1087-1092, 14 figs. Describes three processes of tube making employed by the Bridgeport Brass Co., piercing, cast shell and cupping.

TUNNELS

Hetch-Hetchy Aqueduct

Hetch-Hetchy Aqueduct Tunnel. Public Works, vol. 48, no. 22, June 12, 1920, pp. 508-509, 2 figs. Details of 18-mile concrete lined 11 ft. 3 in. x 11 ft. 3 in. rock tunnel through Sierra-Nevada mountains, which is to deliver 400,000,000 gallons of water to San Francisco daily.

TUNGSTEN

Determination in Ores

A Volumetric Method for the Determination of Tungsten in Ores and Concentrates, George M. Enos. Pahasapa Quarterly, vol. 9, no. 3, April 1920, pp. 131-135, 1 fig. Method consists in acidifying solution of alkaline tungstate with sulphuric acid and reduction of tungsten from hexavalent to tetravalent state in acid solution by means of Jones reducer, and finally oxidizing tungsten to hexavalent condition with standard solution of potassium permanganate.

Powdered

The Manufacture of Pulverized Tungsten in France (La fabrication du tungsténe en poudre en France). Jl. du Four électrique, vol. 29, nos. 7 and 8, May 1 and 15, 1920, pp. 62-63. Purification is effected directly on mineral, instead of on tungstic acid. Sulphur, arsenic and phosphorus are eliminated by several roastings and tin and silica by special electromagnetic treatments.

TURBO-GENERATORS

Compound Conductors

A Uniform Distribution of Heavy Currents over the Several Sections of a Compound Conductor. (Gleichmässige Verteilung grosser Stromstärken auf mehrere Teilleiter), Franklin Punga. Elektrotechnische Zeitschrift, vol. 41, no. 4, Jan. 22, 1920, pp. 69-71, 8 figs. It is pointed out that in the construction of large turbo-dynamos the problem arises of distributing the current equally over the several sections of a compound conductor, and different examples are cited to show how this is accomplished.

U

U. S. ARMY

Construction Division

The Construction Division of the Army, R. C. Marshall, Jr. Jl. of Franklin Inst., vol. 189, no. 5, May 1920, pp. 581-601. Summary of work done during world war.

UNIVERSAL JOINTS

Stresses Developed

The Action of Forces in Universal Joints (Das Kräftespiel im Kreuzgelenk), D. Thoma. Schweizerische Bauzeitung, vol. 75, no. 17, April 24, 1920, pp. 187-188, 4 figs. Writer points out that a universal joint transmits to the shafts besides the twisting moment, also periodically changing bending moments as soon as the directions of the two shafts deviate from one another. Determination of kinematic relations and extent of bending moment caused by a given coupling.

V

VACUUM TUBES

Shortest Waves Produced

The Shortest Waves Which Can Be Produced with Vacuum Tubes (Die kürzesten, mit Vakuumröhren herstellbaren Wellen), H. Barkhausen and K. Kurz. Physikalische Zeitschrift, vol. 21, no. 1, Jan. 1, 1920, pp. 1-6, 5 figs. Notes on length of waves, hypothesis of the occurrences in interior of tubes and influence of shape of tube. Results of experiments are said to show that shortest possible wave, produced with a 2.1 cm. in diameter Schott tube at 500 volts at grid and very high temperature, was 43 cm. long. Report from Torpedo Inspection laboratory.

Thermionic

Thermionic Vacuum Tube as Detector, Amplifier and Generator of Electrical Oscillations, W. H. Eccles. Elecn., vol. 84, no. 2190, May 7, 1920, pp. 522-524, 8 figs. Notes on space charge; addition of a third electrode, or grid; cascade amplifier; application of triode tubes, application of beat principle, cumulative rectification, etc. Abstract of two lectures delivered before Royal Inst.

See also RADIOTELEGRAPHY, Experiments.

Uses

Vacuum Tubes and Their Uses (Les tubes a décharge électronique et leurs applications), P. Letheule. Génie Civil, vol. 76, nos. 18, 19, 20, 21 and 22, May 1, 8, 15, 22 and 29, 1920, pp. 413-417, 5 figs., pp. 432-435, 6 figs., pp. 453-455, 7 figs., pp. 472-475, 6 figs., pp. 491-492, 6 figs. Theory of three-electrode apparatus. Uses as detectors. Heterodyne method of receiving maintained waves. Operation of triode valve as amplifier. Reinforcement of signals by regulation of return of energy from plate to grid. (Continuation of serial.)

VALVES

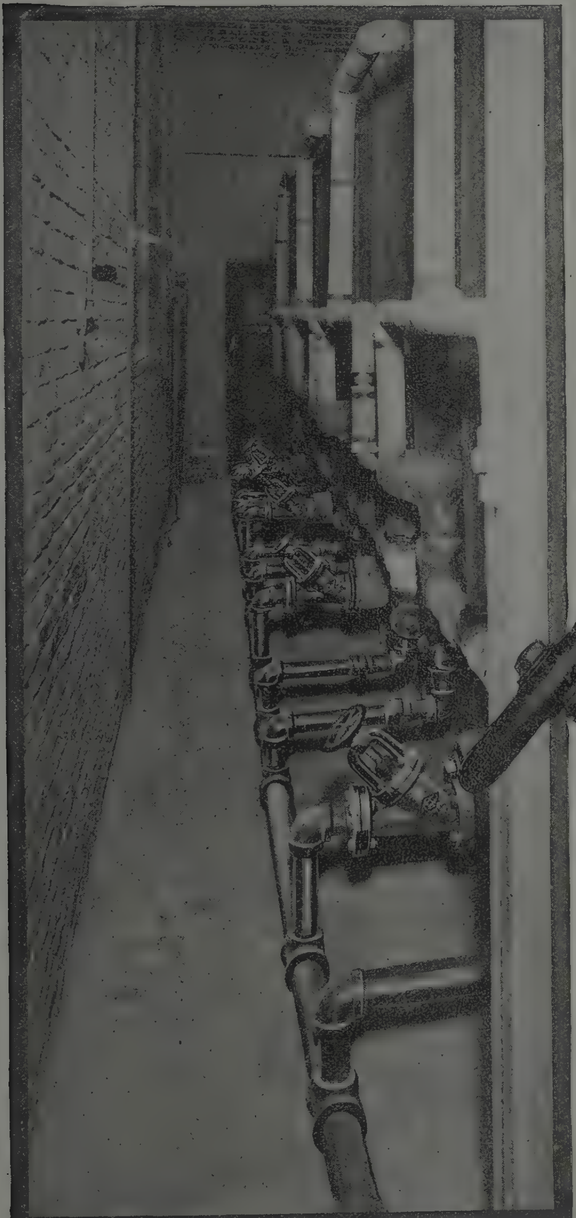
Steam

New Devices for Steam Piping (Interessante Neuerung für Dampfleitungen). Schiffbau, vol. 21, no. 17-18, Mar. 17-24, 1920, pp. 528-530, 4 figs. Description and illustrations of a new valve called the Borsig Ideal Valve (A. Borsig Machine Works, Berlin-Tegel), some advantages of which are said to be uninterrupted free passage through valve, avoidance of pressure losses, higher speed and therefore smaller piping, less radiation losses in connection with warm media, reduced cost for attendance and repair, etc.

Hydraulic, Balanced

Balanced Hydraulic Valve. Eng., vol. 109, no. 2826, Feb. 27, 1920, pp. 281-282, 6 figs.

Jenkins Y or Blow-off Valves



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ENGINEERING INDEX (Continued)

Valve design to eliminate leakage at moving parts and balanced both at inlet and exhaust ends.

VENTILATION

Auditoriums

The Ventilation of Large Auditoriums, Ray S. M. Wilde. Jl. of Am. Soc. of Heat. & Vent. Engrs., vol. 26, no. 3, April 1920, pp. 353-356. Advantages and disadvantages of various systems are discussed. Opinion is expressed that down-feed system, where fresh air, cooled or heated, is supplied through main ceiling and foul air exhausted at floor line, is best method of air distribution for large auditorium.

Sizing of Ducts and Flues

The Sizing of Ducts and Flues for Ventilating and Similar Apparatus, H. Eisert. Jl. of Am. Soc. of Heat. & Vent. Engrs., vol. 26, no. 3, April 1920, pp. 325-340, 5 figs. Tests of Prof. Rietschel with ducts of widely differing sizes and shapes and air velocities within wide ranges are said to have established that (1) in duct of uniform cross-sectional area coefficient of friction decreases with increase of velocity of flow, and (2) velocity of flow and other conditions being the same, coefficient of friction decreases with increase of cross-sectional area of duct. Results obtained with use of Rietschel coefficient of friction are compared with those obtained with use of Taylor coefficient.

[See also SHIPS, Ventilation of.]

VISCOSIMETERS

Falling-Sphere

The Falling Sphere Viscosimeter, William Howieson Gibson and Laura Mary Jacobs. Jl. Chem. Soc., vols. 117 & 118, no. 691, May 1920, pp. 473-478, 1 fig. Apparatus in use in Government laboratories.

Holde, Tables for

Tables for the Holde Viscosimeter (Tabellen für den Holde'schen Zähigkeitsmesser), Karl Scheel. Roholindustrie, vol. 10, no. 12, Dec. 1919, pp. 213-215. It is pointed out that Holde has supplemented his former measurements with measurements for fluid substances, such as petroleum, benzol and thin lubricating oils, and results of combined old and new measurements are presented in tabular form.

Hydrogen Capillary

The Viscosity of Solutions of Cellulose, William Howieson Gibson. Jl. Chem. Soc., vols. 117 & 118, no. 691, May 1920, pp. 479-493, 3 figs. Description of hydrogen capillary viscosimeter.

Workshop

A Workshop Viscosity Meter. Eng., vol. 109, no. 2833, Apr. 16, 1920, p. 509, 2 figs. Consists of cup with handle and ball, both of same curvature. Oil is poured in cup and ball is then pressed against it. Time in which ball drops clear of cup when instrument is inverted, divided by constant, gives oil viscosity in absolute units.

W

WAGES

France

Excess Wages Paid to Heads of Families (Le sursalaire familial), Paul Razous. Génie Civil, vol. 76, no. 21, May 22, 1920, pp. 475-477. Practices of French companies. One company, for example, gives excess wages of 240 francs a year to employees having one child, 600 francs a year for two children, and 600 francs a year for each child above two.

German Mechanics

The Cost of Labor in Germany. Am. Mach., vol. 52, no. 23, June 3, 1920, pp. 1197-1198. Tables showing minimum wages paid to mechanics in different parts of Germany according to recent wage agreements.

Gradual Rise of

The Evolution of Wage and Price Levels, H. H. Manchester. Am. Mach., vol. 52, no. 22, May 27, 1920, pp. 1123-1127, 2 figs. Historical study of relation between wages and their producing power.

[See also BONUS SYSTEMS.]

WALLS

Hollow-Block

The Insulating Value of Hollow-Block Walls (Die Mauerstärken von Hohlsteinmauern), Fritz Emperger. Beton u. Eisen, vol. 19, nos. 1 and 2-3, Jan. 8 and Feb. 4, 1920, pp. 5-6 and 25-26, 10 figs. Comparison of five different forms which can be selected for hollow-block construction in order to lengthen route traversed by heat and dampness in passing through the wall.

WARSHIPS

Battle Cruiser H. M. S. Hood

H. M. S. Hood, Eustace D'Eyncourt. Eng., vol. 109, no. 2830, Mar. 26, 1920, pp. 423-426, 3 figs. Principal data: Length between perpendiculars, 810 ft.; length overall, 860 ft.; breadth, extreme, 104 ft.; load draught, mean, 28 ft. 6 in.; displacement at load draught, 41,200 tons; speed at load draught, 31 knots; oil fuel capacity, 4000 tons.

H. M. Battle Cruiser "Hood." Eng., vol. 109, no. 2830, Mar. 26, 1920, pp. 397-399 and 414, 16 figs, partly on 4 supp. plates. Notable departure from existing types is "blister" surrounding main hull of ship as protection against effective attack by torpedo. Propelling machinery consists of four sets of Brown-Curtis turbines driving propeller shafting through single reduction gearing.

British Battle Cruiser Hood, Eustace D'Eyncourt. Int. Mar. Eng., vol. 25, no. 6, June 1920, pp. 492-495, 3 figs., partly on supp. plate.

Destroyers

Geared Turbines for Torpedo Boat Destroyers. Int. Mar. Eng., vol. 25, no. 6, June 1920, pp. 479-480, 2 figs. Arrangement of engine room in U. S. S. Clemson. Particulars of destroyer are: Displacement, 1200 tons; horsepower, 28,000; speed, 35 knots.

Reduction Gears

Experience and Practice in Mechanical Reduction Gears in Warships, H. B. Tostevin. Eng., vol. 109, no. 2832, April 9, 1920, pp. 474-480 and p. 482, 16 figs. Changes introduced since 1910 in type then first adopted by British Admiralty. Attention is particularly directed to sprayer used for lubricating reduction gears of British torpedo-boat destroyers. Paper read before Instn. Naval Architects.

WASTE ELIMINATION

Industrial Opportunities for

Fields for Investigating Waste Elimination, A. Thau. Iron Age, vol. 105, no. 17, Apr. 22, 1920, pp. 1155-1157. Writer points out that there are a number of works which without their revenue being supplemented by substantial income from their by-product plants would financially be unable to exist, and tells how coke oven by-product recovery began. He adds notes on heat of discharged coke for steam making, putting incandescent coke into blast furnace, a coke-quenching machine in England, and utilizing carbon dioxide from chimneys in a German iron works.

WATER GAS

Gas-Oil Situation

Gas Oil Situation Analyzed, J. B. Klumpp. Gas Age, vol. 45, no. 11, June 10, 1920, pp. 503-506, 1 fig. Statement prepared by Gas-Oil Committee of Am. Gas Assn. for emergency committee conference.

Gas Oil Supply Prospects, N. A. C. Smith. Gas Age, vol. 45, no. 11, June 10, 1920, pp. 500-502, 1 fig. Advocates reduction of wasteful practices in uses of gas oil of enriched water gas.

Production

Addition of Water Gas to City Illuminating Gas (L'introduction du gaz "a l'eau" dans le gas "de ville"), A. Grebel. Génie Civil, vol. 76, no. 13, March 27, 1920, pp. 305-312, 12 figs. Economies resulting from adding water gas to city illuminating gas are pointed out, and various processes of manufacturing water gas are described, notably Dellwik-Fleischer and Humphreys-Glasgow.

WATER HAMMER

Calculation of

Calculation of Water Hammer in Conduits Formed of Two or Three Sections of Different Diameters (Calcul de coup de bélier dans les conduites formées de deux ou de trois tronçons de diamètres différents), Ed. Carey. Bulletin Technique de la Suisse Romande, vol. 46, no. 10, May 15, 1920, pp. 111-115, 6 figs. Formulæ for various special cases. (Continuation of serial.)

WATER TREATMENT

Chlorination

Chlorination as a Means of Disinfecting Municipal Water Supplies, G. G. Nasmith. Contract Rec., vol. 34, no. 23, June 9, 1920, pp. 532-537. Advantages of method, with notes on amounts of chlorine required by different waters.

Pumps

Modern Pumps for Small Water Works, Creed W. Fulton. New England Water Works Assn., vol. 34, no. 1, March 1920, pp. 1-22 and (discussion) pp. 23-27, 11 figs. Pumps for plants where daily consumption does not exceed 3,000,000 gal.

WATER WORKS

Motor-Driven Pumps

Motor Driven Centrifugal Pumps at Quincy, Ill., W. R. Gelston. Public Works, vol. 48, no. 22, June 12, 1920, pp. 504-507, 1 fig. Both low-lift and high-lift pumps and booster pumps are driven by electricity. Water Department finds these pumps "economical and very reliable and satisfactory," and it is said that reserve steam equipment is seldom used.

Toronto

Growth of New Toronto Waterworks System from Village Supply to Large Plant, E. M. Proctor. Contract Rec., vol. 34, no. 23, June 9, 1920, pp. 518-522, 12 figs. Present average daily pumpage is 2,500,000 gal.

WATTMETERS

Thermal

The Thermal Storage Demand Wattmeter, Paul M. Lincoln. Elec. Jl., vol. 17, no. 6, June, 1920, pp. 253-256, 6 figs. Schematic diagram of operation. Reference is made to article in Trans. Am. Inst. Elec. Engs., vol. 37, p. 189, explaining principle of operation of thermal wattmeter.

WELDING

See AUTOGENOUS WELDING; ELECTRIC WELDING, ARC.

WIND TUNNELS

Air-Flow Visualization

Study of Flight Vortices, F. W. Caldwell and E. N. Fales. Eng., vol. 109, nos. 2833 and 2834, April 16 and 23, 1920, pp. 501-504, 9 figs. and 534-537, 15 figs. Method of visualizing air flow in wind tunnel by fog condensation of moisture in air is explained and photographs of flight vortices thus obtained are presented.

Model Experiments

Wind Tunnel Studies in Aerodynamic Phenomena at High Speed, F. W. Caldwell and E. N. Fales. Nat. Advisory Committee for Aeronautics, Report No. 83, 1920, 52 pp., 42 figs. Description of model wind-tunnel experiments, McCook Field wind tunnel and of method there employed of visualing flight vortices by condensation of moisture in air, together with account of model tests on propeller aerofoils.

Static Pressure Gradients

Static Pressure Gradients in Wind Tunnel Work, J. G. Coffin. Aviation, vol. 8, no. 8, May 15, 1920, pp. 317-318, 4 figs. Formula for computing tunnel axis force, and method of computing pressure-gradient corrections.

[See also LABORATORIES, Aeronautic.]

WIRE ROPE

See ELEVATORS, Ropes.

WOOD

Drying

Phenomena of Drying Wood, Harry D. Tiemann. Jl. of Franklin Inst., vol. 189, no. 5, May 1920, pp. 645-648, 1 fig. Analogistic explanation of "casehardening" or the relations of "set" and stresses that occur in drying wood.

WOODWORKING INDUSTRY

Costs

Accumulation of Costs in Woodworking, Carle M. Bigelow. Indus. Management, vol. 59, no. 6, June 1920, pp. 480-482. Interpretation of woodworking factory costs.

WORKMEN'S COMPENSATION

Kentucky Coal Mine

Coal-Mine Compensation in Kentucky, Herbert M. Wilson. Coal Age, vol. 17, no. 25, June 17, 1920, pp. 1259-1262. Inspection reports, safety-engineering service, low cost and checking up of experience records are said to be features of system designed to exceed possibilities of mutual or self-insurance.

[See also LADDERS.]

Z

ZINC INDUSTRY

Oklahoma, Missouri and Kansas

The Zinc Industry of the Tri-State Field, Francis Judson Tietsort. Compressed Air Mag., vol. 25, no. 5, May 1920, pp. 9635-9643, 15 figs. Survey of conditions with notes on future production and marketing problems. Work of Am. Zinc. Inst. in developing zinc industry is noted.

Mechanical Engineering

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C. 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

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Contributors and Contributions

The Need of Research in the Industrial Field

Dean P. F. Walker

The leading article of the month comes from Dean P. F. Walker, of the School of Engineering, University of Kansas. His subject is one of great importance at the present time, as it is no exaggeration to say that upon the economic status of our industries depends the future welfare of the entire country. Dean Walker has given considerable study to the problem of which he writes. He is chairman of the Research Committee of the Mid-Continent Section of The American Society of Mechanical Engineers, and is also connected with Kansas state organizations actively engaged in this highly important work. His paper thus reflects the conception of these matters as held by those intimately connected with their development, and it deserves careful and thoughtful consideration.

Alloy Steels, Their Heat Treatment and Uses

The current number contains two papers dealing with the important and interesting subject of the heat treatment of alloy steels. One comes from H. J. French, metallurgical engineer at the Bureau of Standards, the other from A. H. Miller of the research department of the Midvale Steel and Ordnance Company. Mr. French's paper treats of the application of alloy steels, particularly those of the nickel-chromium variety. Mr. Miller's paper deals with the heat treatment of the steels themselves. Both papers will repay careful reading.

The St. Lawrence River Project

A method of reducing the transportation congestion on the Atlantic Coast is advanced by Mr. Horace C. Gardner in this issue. The long-standing problem of relieving the railroad load during the season of shipping crops to the sea-board may be solved by developing the St. Lawrence River. That this solution must have consideration is believed thoroughly by a considerable number of business men in the Middle West. This paper will appeal to engineers who, as a body, are interested in the great question of the day, that of transportation.

Alloyed Aluminum as an Engineering Material

G. M. Rollason, of the Aluminum Casting Company, writes in this number of one of the most interesting materials known to engineers. Aluminium is a metal which is well adapted to a great variety of engineering uses. Upon its discovery, however, it was proposed for every imaginable purpose, and because it failed to do all that was expected of it a distrust of the metal was created, which even now has not been lived down. Mr. Rollason traces the history of the uses of the metal and its alloys and makes some interesting prophecies as to their future application. He also discusses the methods now employed in its casting and working.

The Training of Engineering Students in Industrial Management

Bruce W. Benedict

The University of Illinois has one of the largest and best-equipped series of shops for the instruction of its students in mechanical engineering of any technical school in the world. Standard commercial equipment is used, and a regular line of machines is produced on a manufacturing basis. The shops are under the direction of Bruce W. Benedict, who believes that a chief function of the engineer is to manage human enterprises. In this spirit he has developed in connection with the shop laboratories a unique and effective course in industrial management which he describes in this number. In view of the widespread interest in management problems and the training of men to undertake them successfully, this article is recommended for its helpful suggestions.

Other Articles of the Month

Dr. Paul G. Agnew, Secretary of the American Engineering Standards Committee, recently returned from a trip to England and the Continent. The current issue contains an abstract of his report describing the status of standardization in foreign countries. A review of accomplishment in standardization work in this country is also given.

The Federated American Engineering Societies is the greatest organization of its kind in the history of the world. Its constitution and by-laws will be found in full on pages 541-543.

The main portion of the Survey of Engineering Progress in this issue is devoted to the problem of Hydraulic Power machinery, its operation and development. This Survey affords an opportunity for keeping in touch with the live issues in engineering.

A.S.M.E. AFFAIRS

In future issues of MECHANICAL ENGINEERING this space will contain brief notices of the current activities of The American Society of Mechanical Engineers. Complete details of all meetings, Committee activities, Council decisions, etc., will be found in Section 2.

THE ANNUAL MEETING
December 7-10, 1920
For Details See Section 2, Page 121

MECHANICAL ENGINEERING

Volume 42 September 1920 Number 9

The Need of Research in the Industrial Field

The Study of the Economics of Location—The Scope of the Work and the Engineer's Part Therein—Industrial Research in the Middle West—The Power Problem in the West

By P. F. WALKER,[1] LAWRENCE, KAN.

The following paper is a discussion of the problems which await the research engineer in the field of industry. The author first outlines the various studies which he considers of fundamental importance. He lays particular emphasis upon the study of the economics of the location of an industry, pointing out in this connection the unfortunate conditions which now exist in Kansas and the neighboring states solely because this problem is as yet unsolved. The solution of the problem, the author states, is distinctly an engineering one, and he accordingly next presents a discussion of the engineer's part in the field of industrial research. He also outlines the scope of the work which in his opinion should be undertaken. The concluding portion of the paper is an abstract of a report prepared by the Research Committee of the Mid-Continent Section of The American Society of Mechanical Engineers, of which the author is chairman. It deals with the status of industrial research in the Middle West and covers all phases of industry. It is divided into three groups: (1) the food group, (2) the fuel group, and (3) the miscellaneous group, the latter comprising such industries as mining, cement manufacture, metal manufacture, etc. The paper is a comprehensive summary of the status of industrial research in the Middle West and a concise statement of the great need for such research throughout the entire United States.

INDUSTRIAL research is a term now coming into frequent use. There appear to be, however, about as many variations in the meaning assigned as there are persons using it, so it may not be out of place to briefly discuss its several phases before giving attention to the particular kind of work and study to be discussed in detail. This is not for the purpose of imposing the writer's personal definition on any one, but merely for the sake of clearness.

Strictly speaking, all engineering research is industrial. So also is all research in either pure or applied science laboratories, if the results are of a nature such that they can be given direct application in industrial operations or designing. One of the most apparent tendencies is to make a distinction between the laboratory of a public institution and the laboratory of a manufacturing or other business firm, calling the work done in the latter industrial research. As a matter of fact the same kind of work may be going on in both. The private firm, it is true, is looking for results applicable to its own business, but the results of the other may also be applicable there. It is a distinction based on motive, and form of organization, rather than on kind of research.

Another distinction is sometimes made by placing the study and development work carried out with commercial equipment already in operation in the business, in a different category than similar work being done for the purpose of experimentation with equipment set up to simulate operating conditions. Both, presumably, are technical studies, and the only possible difference lies in the facilities which may be provided in the latter case for securing observations. Such a distinction would have the effect of branding industrial research as inferior in scientific character and perhaps superior in commercial value. This is obviously an improper sort of classification.

A distinction based on the character of the work is made by including in the term "industrial" the study and analysis of organization and management problems, as distinguished from technical work based on physical science. This view is well represented in the interesting article by Mr. Hirshfeld in the February 1920 number of MECHANICAL ENGINEERING. Industry is now in that period of development where the most marked increases in the rate of production come from development of the works personnel, rather than from refinements in mechanical equipment. Many of these developments are far past the experimental stage in some branches of industry, but work still remains to be done to show results in many others.

THE STUDY OF THE ECONOMICS OF LOCATION

But there is still another line of study that can be called industrial research, different in kind from work based on physical science. It has to do with the economics of location of industrial enterprises and with the possible development of natural resources in any given locality. In order to make a clear statement of the methods that may be followed in such work certain general principles will first be given a brief discussion. In passing, it may be observed that the war called attention to the importance of developing certain essential industries in this country, and this fact while somewhat aside from the main line of thought, is of prime significance.

The distribution of goods is the greatest industry in the world. In the United States it has become especially large in comparison to other activities, because of the great extent of country and the high per capita wealth which stimulates buying. The absence of a peasant class means that in every nook and corner of the land people are in the market for the highest classes of every line of commodities. This means that shipments of standard goods follow population groupings in approximately uniform quantity.

What this means is indicated by the following illustrations. In a simple everyday commodity like starch the state of Kansas calls for the shipment of 2000 tons annually, the haul being mainly from Illinois and eastern Iowa, an average distance of perhaps 500 miles. This means one million ton-miles of traffic imposed on the railroads, although Kansas ships out many thousands of tons of corn.

A single small city in Kansas, Garden City, on the main line of the Santa Fe railroad, ships thousands of tons of alfalfa meal and dried sugar pulp for dairy feed to the southern states. The town does not have even a small dairy-products plant, hence it must in turn ship in its butter, notwithstanding the fact that it is in the midst of a cattle country. In varying degree this statement applies equally well to scores of towns in several states. The dairy-feed traffic probably amounts to several hundred millions of ton-miles annually, near half of which could be eliminated by a scientific distribution of manufacturing enterprises.

A condition more vitally wrong exists in the handling of lead and zinc ore. Forty per cent or more of the output of the United States comes from a small area near the corner junction of Oklahoma, Missouri, and Kansas, a few miles east of the oil and gas belt. The concentrated ore is first shipped to smelters in the gas field, a proper procedure because it saves transportation of fuel. But from here the greater part of the spelter in semicrude form is shipped to New Jersey, and finally the finished metal, in sheet or other stock forms, is again shipped, some to the states of its origin, and much of it to states much nearer that origin than to the rolling mills of New Jersey.

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Many other instances of unnecessary traffic might be cited. An unavoidable freight producer is the group of standard food products—meat, fruit, and cereals. The origin of this traffic is in the grain belt west of the Mississippi River, on the stock ranges of the West and Southwest, and in the fruit districts of the Pacific and Gulf states. Granted that, in the main, the movement is always toward the markets, a greater saving will nevertheless result when the center of population moves further westward from its present location in Indiana and this will be accomplished as the trans-Mississippi states experience the industrial development which the full utilization of their resources makes reasonable.

As a matter of fact, the agricultural states are facing a disturbing situation which has a reflex effect on the country as a whole, threatening the food supply of the nation. These states are near a standstill in population, if not actually losing ground. Out of the 105 counties of Kansas, sixteen prevented the state from declining in population during the decade ending in 1915. These sixteen are the ones having the important manufacturing industries and hence the largest cities. The agricultural counties lost in the aggregate. The same thing holds in Iowa, and doubtless in other states for the same period. This means an undeveloping home market. It means further the absence of those large masses of labor usually found in industrial centers and so necessary during wheat harvest. The seriousness of this lack of labor at the peak of the agricultural load is not realized by people far removed from the grain states. In 1919 the farmers in western Kansas counties were paying eight and even ten dollars per day, and usually for incompetent labor, and even at that were short-handed. This condition so increased the cost of production that in many cases in spite of the high price of wheat net incomes were almost wiped out. The result has been that the farmers are reducing the acreage to an amount that they can handle with their own labor plus the neighborhood exchanges. This is menacing the food supply. Many a farmer is also without funds to pay his 1919 bills, because the railroads have not been able to move the wheat. The writer has talked with farmers in several of the largest wheat counties of Kansas, and knows that these statements are in accord with the facts.

Some one has said transportation is the neck of the bottle that limits the capacity of the country to produce. But while waiting for the railroads to recoup themselves, why should not industrialists bestir themselves in an effort to check the ever-growing load of freight by a more systematic plan of production? When viewed from the standpoint of a national industrial system industry has grown in a haphazard fashion as to location. Business instinct has been logical and true within the recognized sphere of determining factors, and master minds have built up our successful enterprises. But the controlling factor has been cost of production, based on the assumption that transportation facilities would be adequate to bring the materials and carry the goods to market, irrespective of distance. Sometime a limiting condition will be set on this assumption, and it may be that the time is nearer than has been supposed. It is not too soon to begin to consider a national industrial policy, based on economy of combined production and distribution, in which the associated problems of food and fuel supplies will be given their due consideration.

The Engineer's Part in Industrial Research

The basic principles on which such a coördinate system must be established are scientific in character. It is an engineering problem that is involved, in which the economics of transportation and production are in the foreground. It is the business of the engineering profession to recognize the need and to proceed with the study and analysis of the vital facts. Too often engineers hesitate to enter upon projects wherein financial and economic situations are the first to be met, even when the forces most directly influencing those situations are technical and such that the man with engineering experience can most readily pass judgment upon them. Production and transportation, taken separately, are matters subject to scientific analysis, with which engineers have long dealt. In combination they are no less susceptible to such study and the need for a scientific system is becoming more and more evident.

The investigations in which the writer is now engaged form but a slight part of the complete survey and study indicated by the preceding statements. An attempt is being made to analyze the industrial possibilities of the state of Kansas. It is being done with the coöperative support of the governor's office, and of the state department of industry and labor. Whenever it should become necessary the authority of those administrative agencies may be invoked to open the doors to information respecting individual enterprises, but diplomacy has been uniformly successful in securing all that is needed. Another coöperating agency is the Kansas Engineering Society, of whose standing committee on manufacturing industries the writer is chairman. Also the writer's position as head of the research committee of the Mid-Continent Section of The American Society of Mechanical Engineers is of contributory value, particularly as regards the petroleum industry. Likewise the fact of his being head of the engineering branch of the state university fixes his status as practically that of a state official in such matters. These points of a somewhat personal nature are mentioned merely to show the means at command for making a consistent statistical study of existing conditions.

The Scope of the Work

The work under way naturally divides itself into three branches:

1 A survey of operating conditions in existing enterprises
2 A study of industrial needs of the state
3 A study of the vital economic factors in such kinds of manufacturing as Kansas resources and conditions make it feasible to consider.

Along with these branches of individual effort a certain form of educational campaign has been conducted. The means for this has been an association with the chambers of commerce of the cities, by speaking before gatherings, conference with committees, and providing secretaries with statements of facts as to individual industries. This is akin to promotion work, and as a matter of fact some real promoting is being fostered at the present time. This is special, however, and essentially a private enterprise.

In the survey of existing enterprises the usual routine of the census enumerator is amplified. Volume of business, capital, quantity or value of raw material, employees and payroll, and power, are interesting and valuable items, but in this study the following facts are more to the point:

1 Markets and marketing methods. The section of country served, the nature of the demand for the product, relations with other industries, and trend of development are points of information sought
2 Sources of raw material. Actual original source and the freight rates or other cost of delivery to the plant
3 Transportation facilities, for both raw and finished stock
4 Details of power and fuel supply, cost, etc.
5 Labor conditions. Questions of supply and quality of labor, aptitude of residents of the community for specific kinds of work: also the local situation as to balance in employment opportunities for men and women
6 Reasons why the enterprise was located as it was. Sometimes this reveals only some personal preference, but often there is a well-considered reason
7 Business and social conditions of the town and community.

The second branch of the work—the industrial needs of the state—presents several distinct features. For different regions the problems are different. Many think of the state of Kansas as one great wheat field with a few cattle ranges interspersed. As a matter of fact there is a wide diversity of natural products. In the southeastern counties are the mining interests in coal, lead, and zinc. Just west of that and extending half way across the state is the petroleum district. North of the western end of the oil belt in central Kansas are large deposits of a good grade of salt. In several counties, some northeast and some south of the salt deposits, there are large quantities of workable gypsum. In many sections the clays and shales are furnishing materials for cement, brick, tile, and other ceramic products. Corn, as well as wheat, is grown in all excepting the far-western counties, but almost nothing is done now in the manufacture of corn products. Sorghum cane and its products hold important possibilities, but lightly touched upon as yet. The dairy-products business holds most promising possibilities and is destined to become an important factor soon. Large portions of the seemingly dry western counties have abundant ground water within pumping distance of the surface. Irrigation has been practiced successfully for the growing of sugar beets and alfalfa, and much is to be expected from further developments. Canning and preserving of vegetables and fruit is an industry that has not yet begun to touch its possibilities. These and several other industries are of great promise, many of them being needed to change agricultural methods from extensive wheat growing to an intensive system with diversified crops, the better to realize the food-producing capacity of the soil. Industries producing lines of goods in metal, leather, paper, and cheaper fabrics, already represented in several cities, are capable of extensive development. Any line of manufacturing which produces goods expensive to ship in finished form, from raw material that can be shipped in bulk on a low freight tariff, can be operated successfully in this region. These comments illustrate the line of investigation without covering at all adequately the possibilities of this or any other region.

The third phase is the logical one of analyzing carefully many different lines of manufacturing to determine which ones are best adapted to the conditions in any given locality. Those requiring large amounts of power or process fuel, like the smelters and cement mills, must cling to the coal and oil districts. For others the power demand is small and they may follow markets or raw material. Those for which the value added by the manufacturing process is large can go anywhere, other factors being equal and provided the labor supply is in sight. It is here that we have the final application of all that has preceded, namely, the fitting of the enterprise to the locality. No task is more interesting than the one of providing a locality with an industry or an industry with a locality.

It is submitted that this is a form of service to the state or other district that warrants the attention of engineers. It is a step toward the great enterprise of establishing a comprehensive industrial system that shall take into intelligent consideration all of the factors of production, markets, economy in transportation, economic distribution of population, and maximum utilization of the food-producing power of the country. We have been prodigal in the exploitation of natural resources, but the end of this is coming. To become a true industrial nation means the extension of scientific methods to the broader problems of industry.

Industrial Research in the Middle West

As a definite example of this form of service to the state the writer desires to present, as the concluding portion of his paper, an abstract of a report prepared by the Research Committee of the Mid-Continent Section of The American Society of Mechanical Engineers. This report was based upon that society's action in calling for information regarding industrial scientific investigations in the Mid-Continent Section territory; (*a*) On such topics as may be so well worked out as to warrant a final statement of results; (*b*) On problems now in process of solution or development. A further point was the formulating of information as to facilities available for carrying on research work in the several industries and educational institutions in the same territory. Still another was to take such steps as might be possible toward the securing of funds to be applied in the support of investigations having as their object the improvement and development of the varied industrial interests of that section of the country.

In compliance with this request the committee has applied itself to the carrying out of the program, particularly as to the gathering of data pertaining to investigational and development work now in progress. Circumstances have required, however, that the writer who is chairman of this committee should formulate the report without conferring with other members on matters other than the general intent and scope of the work to be undertaken. Opinions expressed herein are therefore largely his personal ones, for which he assumes responsibility. In general it is to be understood that the ideal that guides in this work is to promote the best interests of the people of this large Mid-Continent area, which in turn touch the interests of the entire country in a most vital manner. Engineering is a profession of service. It is given to engineers to bring the energies existing in nature to the use and convenience of man, and the first concern of those who study the industrial needs of an inhabited region is the economic betterment of the population along lines that are permanent and in accord with a sound national policy. Individual industries are to receive the direct study, of course, and the benefits of such development as might be stimulated thereby, but the motivating impulse lies in the general aim just expressed.

The Scope of the Industries

The industries of the territory which have received consideration may be grouped as follows:

A—The food-products group, including
  1 The beet-sugar industry
  2 The dairy-products industry
  3 The canning and preserving industry
    Note: The two largest industries of this group, meat packing and flour milling, are not included because they have reached such a stage of development as to make generalized study unnecessary, excepting as to choice of motive-power equipment in flour mills.
B—The fuel group, including
  1 The petroleum and petroleum-products industry
  2 Coal mining.
C—Miscellaneous, including
  1 The zinc and lead mining and smelting industries
  2 Cement manufacturing
  3 Metal manufacturing
  4 Other manufacturing, considered as to conditions influencing possible development.

The Food-Products Group

Research work among the industries producing foodstuffs is of that kind having to do with economic conditions influencing their establishment. This is a territory that produces much and is capable of producing much more. The soil is made to yield only a fraction of what intensive methods would make possible, this being strikingly true of the western portions of Kansas and Oklahoma. To bring about the change there is demanded a development in the field of engineering.

The great need of the section of country referred to is for power. Irrigation is necessary to make sure the crops, and this would be provided from the unfailing sheet of ground water if cheap power were obtainable for pumping. In some sections the start has been made, but the mounting cost of fuel oil is making continuance difficult and uncertain.

The Fuel Group

On the coal-mining branch comment has already been made with respect to possible development of a coking and by-products industry. In mining itself the problems are largely with respect to labor and social conditions. Investigations are contemplated by the mining staff of the University of Kansas on such questions as the percentage of extraction being secured under the mining systems now in vogue, and on economic advantages arising from electric underground haulage. It is understood that similar studies are under way in Oklahoma. Engineering problems are much more serious in the Arkansas coal fields than in either

Kansas or Oklahoma, but no information has been secured as to specialized work in that field.

The petroleum industry occupies the center of the stage in this territory, and necessarily comes in for a major share of attention. It has often been said that there is very little scientific engineering work carried on in the oil field. At one time in the history of the industry, undoubtedly this was true. Conditions now are very different, however, and while there are still found those regions where in the flush of new development the methods employed are wasteful in the extreme and based largely upon rules of thumb and traditions handed down through the old rough-and-ready type of oil men, there is at the same time being applied in the representative districts where well-organized companies are in control, a degree of engineering talent and skill not to be surpassed in any industry of the country. Margins are not what they once were, and, in spite of the apparently high rates of return, the safety of the excessively great investments in what may in many instances prove to be short-lived enterprises demand a close and accurate study of those conditions which lead to economy. To the same end there has been necessary a large amount of study and research in the development of processes and of specialized equipment that have made possible the effective handling of an elusive substance upon a basis profitable for the investor and adequate for the market. The uninitiated would be surprised on discovering the amount of attention being given to these scientific problems which have a direct bearing upon the commercial issues of business.

It is necessary to appreciate the demand which is being placed at this time upon the producers of high-grade liquid fuels. This demand is increasing rapidly and the public press is employed frequently by those who would express their convictions that a crisis is being approached when supply will no longer be sufficient to meet demand. It is said by many that the peak of oil production has been reached. It is not in the province of this committee in its report to express opinions on this point, but it is not out of place to remark that the apparent limitations to production in the Texas fields need not occasion as much alarm as it seemingly has in some quarters. There is evident a renewed interest in pushing forward new developments in older fields of Oklahoma and Kansas, particularly in the way of reaching sands considerably deeper than those which have been producing for many years. Results obtained are highly gratifying and there is ample evidence of the existence of a great storehouse of petroleum that as yet has been drawn upon but lightly. This is of particular significance in the present connection because it gives assurance of the continuance of the industry over a period of years during which there may be put into effect the many advanced methods now being perfected in both the producing and treating of oil. It is this which gives special significance to the scientific work that is being carried on.

Our topic divides into two parts, representing the major fields of activity. These are, first, the production of oil, and second, the handling and refining of the oil when once it has been brought to the surface.

Production Problems. It is of first importance that there should be drawn from the producing sand the largest possible percentage of the oil contained therein. How it may be increased is one of the greatest objects of study, and many suggestions have been made covering a wide range as to feasibility of methods. Perhaps the most extreme suggestion is that some day we shall be mining the oil sand, bringing it to the surface for the application of extractive processes more frequently associated with the handling of oil shale. To the practical oil man, however, the first step is the perfecting of producing methods. With lessened cost of production, wells can be operated down to a correspondingly lower output and the sand more completely drained. With lessened cost of drilling, wells may be more numerous and contribute to the same end. With this in view reasearch activities have been directed toward the following:

1 The development of more efficient types of deep-well pumps
2 The development of more efficient types of power-generating equipment as applied at the well
3 The application of new forms of power equipment, notably the introduction of electric power for deep-well and surface pumping and also drilling
4 The recovery of oil from the troublesome water-oil emulsion so commonly met with in most producing fields
5 The perfection of methods for extracting the gasoline otherwise carried to waste in vapor with natural gas, commonly designated as plants for manufacture of casing-head gasoline
6 The problem of water supply, frequently a serious one where quantity and quality of the water are vital factors
7 The development of accurate metering devices for both oil and gas.

A great amount of time, talent, and capital has been expended upon each of these problems, upon any one of which a complete paper might well be written. To the writer the most interesting and seemingly the most striking of these are the application of electric motors in the field, the perfection of dehydrating plants for the recovery of oil from emulsion, and the casing-head gasoline plants.

The accomplishment of the first of these three is dependent upon a supply of electrical power. This condition is met in most admirable manner in the El Dorado field in Butler County, Kansas, where a high-voltage power line leads directly from the plant of the Kansas Gas and Electric Company of Wichita to a substation maintained by the Empire Gas and Fuel Company. From this substation current is distributed to the entire field. A great amount of specialized design was necessary in order to produce machinery adapted to the service, but this has been accomplished in a most creditable manner. It should be observed in passing that continuity in operation is a most important factor in preserving the productivity of an oil well.

No one problem has called for more careful study than has the design of dehydrating plants for the recovery of oil from emulsion. Probably the most effective system has not yet been evolved. The one in most common use involves the centrifuge principle, wherein the last step in extraction is brought about through centrifugal force. Efficiency of this system is such that less than one per cent of water remains. One process which has been demonstrated to be successful involves the principle of passing the water-and-oil mixture through a strong magnetic field, breaking the oil film and permitting the water to separate at once by gravity. Developments in this line are rapid, so that one sees much discarded equipment which has become obsolete in the presence of improvements.

In the field of production of casing-head gasoline there is active discussion as to the relative merits of the two systems, designated as the compression and the absorption methods. Experience seems to indicate that each one has its field of application. Apparently the gas less rich in condensable vapor is handled more effectively by the absorption method.

To further illustrate the investigational work which the successful operation of an oil property makes necessary, the following researches accomplished by one company are mentioned. These tasks have been accomplished through detailing to the work regular members of the operating staff of a single department.

1 The conducting of an extensive series of tests for volumetric efficiency of compressors drawing gas from wells under widely varying pressures. This was especially well done when considered as an isolated piece of work, and made possible the proportioning of equipment to demand on a scientific basis
2 The carrying out of extended tests on total gasoline content of gases before and after the application of the casing-head gasoline process
3 The determination of shrinkage of volume of gas while being thus treated by the compression method
4 The determination of evaporation losses from blends of casing-head gasoline with heavier oils when handled at different temperatures.

Handling and Refining Problems. In the transportation of oil by pipe line much analytical work has been done which cannot be reported upon in detail. Records of this work are in the files of the larger companies, and all that can be said is that engineering talent of a high order is being employed in maintaining service.

Problems that are obviously calling for solution in the development of equipment are those relating to the determination of constants for the flow of heavy oils in pipes, and the development of more efficient pumping machinery. Here again the question of power supply enters as a factor. With this mere mention the question of pipe-line transmission will be dismissed.

The problems of the refinery are many and complicated. Many of them come within the range of the chemist rather than of the mechanical engineer. Development work to perfect the process of cracking of oils to increase the yield of gasoline still continues, many companies being engaged in this work.

With the larger refining companies the following are problems continually discussed and for which the positive final solutions have not been found:

1 Determination of the exact amounts of heat required to vaporize oils of different densities and characteristics
2 The rate of conduction of heat through metal surfaces where oil is one of the media involved in the transfer
3 The proper design of furnaces for stills when handling (*a*) crude oil; (*b*) residues under pressure
4 The coefficient of expansion of oils
5 Fuel-economy problems, including the design of the most efficient oil burner
6 Devising of a method for the mechanical separation of wax from lubricating-oil stock
7 Successful methods for the treating of sulphur crudes
8 The development of synthetic processes for by-products, such as ammonia, dyes, perfumery, etc.

Progress in refining methods in the petroleum industry is of peculiar importance. Developments which have been made in recent years have greatly increased the production of the lighter and more valuable fuels, without which the market today would be in a much more critical condition. The chemist and the engineer are working together to improve existing methods and to devise new ones, and the end is not yet. All of the eight unsolved problems mentioned are subjects of study from which a mass of valuable data will be forthcoming in the near future.

The Miscellaneous Group

The lead- and zinc-mining industry is one of the most important activities in the Mid-Continent territory. What is needed most is a stabilization of the demand for zinc plate. This metal is adaptable to many uses outside of the galvanizing and alloy business, and some pioneer work along this line would be productive of results. Some of the same conditions hold for the cement-manufacturing industry. This is a line of business, however, for which an active organization directs the necessary advertising and maintenance of market conditions.

Only one line of research is mentioned, namely, a close study and analysis of power distribution and costs, which has been in progress for some time at the plant of the Lehigh Portland Cement Company at Iola, Kan. That work was interrupted by the war, but will be renewed during the next year.

Metal manufacturing in the territory has been added to by the installation of several new plants which are engaged mainly in the oil-well supply business. One thing greatly needed is a source of supply of a good grade of metallurgical coke. Important investigations on possibilities of coking the mid-western coals are under way in Illinois and Kansas, and it is hoped that some help will be afforded the foundrymen in the not far distant future.

The Power Problem in the West

In preceding sections reference has been made to the need of cheap power for several important industries. This is a matter that is holding back industrial development in a large area. Coal in the region west of a north-and-south line not far from Tulsa is scarce and high in price. Under ordinary conditions oil is too valuable a fuel for use under steam boilers, and its availability for internal-combustion engines is becoming limited while the high price is having a marked effect on cost of generation of power in small units. Present assured markets make the promoting of an extended system of interlocking generating plants markedly hazardous.

Conditions indicate a possible revival of the producer-gas enterprises that were checked in development by the rapid extension of the petroleum fields about fifteen years ago. The lignites of the northwest hold the balance as regards original sources in this matter. The successful outcome of such a proposition rests with the engineering profession, and a reward is in store for those who provide the solution for this on a large scale. Before it can be accomplished, however, it will be necessary to construct a new line of north-and-south railroad connecting the northwest with this great semi-arid region in the western portions of Kansas, Oklahoma, and Texas—a bit of railroad construction that is well worth considering. The region in question has untold possibilities for the maintenance of the food supply of the nation.

Research Agencies in the Section Territory

The exclusively research institution in the territory is the Oil and Gas Experimental Station of the United States Bureau of Mines located in Bartlesville. The station has been active on several phases of the oil industry, its principal lines of study at the present time being:

(*a*) Dephlegmating towers for refinery stills
(*b*) An investigation of the underground conditions of the Hewitt Field
(*c*) Increased recovery from oil properties
(*d*) Evaporation losses from storage tanks
(*e*) The recovery of gasoline from uncondensed still vapors in refineries.

It has also taken up the question of water supply and the effect of water impurities on oil products.

There are three state universities and two state colleges of agriculture and mechanic arts within the limits of the territory. Research facilities exist at all of these institutions, and in at least three of them active steps are being taken to engage in investigations of direct interest to the petroleum industry. Mention has been made of work in progress at the University of Kansas. In addition a productive study has been made during the year just ending of the treatment of oil shale. Plans are now definitely made for taking up in the fall two of the problems mentioned in the refining section: namely, the conduction of heat through metal plate with oil as one of the media of exchange, and the latent heats of evaporation of oils of varying gravity. At the Oklahoma institutions preparations are being made for an extended study of chemical problems.

But the significant element in research in this territory is the part taken by the organized staffs of the larger oil companies. All have engineers and chemists whose time is given in considerable part to new problems, and if all that is being accomplished in this way could be brought to light the extent of the work would be a matter of much surprise. In this organized work the Empire Gas and Fuel Company holds a conspicuous place with its full-fledged department of engineering research. An independent agency like this committee can gain access to the results of such activities, and by adopting a conservative policy as to publication such as will retain it in good standing with the companies which cannot be expected to throw everything open to the public which it has learned through the expenditure of much effort and money, it can accomplish much for the good of the profession of engineering and of the industry.

The time is ripe for bringing to bear upon this important industry the best and united efforts of all technical and scientific men. Quoting from a recent publication of the Bureau of Mines: "The time has arrived when, with crude oil higher than it has been for 50 years, inefficiency in the production and manufacture of petroleum should not be countenanced. Petroleum and its products should be reserved for those uses for which it is peculiarly adapted and for which there are no substitutes."

The Training of Engineering Students in Industrial Management

By BRUCE W. BENEDICT,[1] URBANA, ILL.

The author of the following paper presents the details of a pioneer experiment in the method of teaching industrial management to engineering students. The field of engineering is broad in its scope and purpose and there is a constant call for men trained to perform a multitude of diversified tasks. The technical schools, however, cannot attempt to train men for special tasks, but the presentation of the fundamentals of engineering must nevertheless be governed by the needs of present engineering practice rather than by traditional academic considerations. With this thought in mind the University of Illinois has organized its school shops upon a commercial basis, the details of the system employed and the manner of conducting the work being described by the author. The plan is an exceedingly simple one and is based upon a recognition of the fact that the engineer is primarily a manager of human enterprises rather than a technician making plans for others to execute. The paper is not intended to present the specifications for a complete course in industrial management designed to develop executives and managers from untrained men within the course of a few weeks, but it does outline an experiment in the development of engineering leadership which it is hoped will be fully realized.

IF we accept the proposition that "the ultimate aim of engineering is reduction in cost of the elements of living through the development of improved facilities for changing raw materials into usable products," we have a definite guide for the training of engineers, and the prospective engineer has an equally definite ideal to direct him in preparing for and carrying on his life's work. It is not certain that technical schools generally have been guided by ideals which embrace the broad function of engineering as just defined, nor is it clear that the engineering profession as a whole is, or has been, inspired by adequate conceptions of its task. Engineers to a great extent have narrowed their field of activity to design and construction. Their genius has been directed toward the building of engineering works, but with the completion of the physical structure they have taken themselves off to similar tasks elsewhere, leaving operation to other hands. Operation is a prime function of engineering. It is the final link in the cycle which makes engineering work of value to man, and engineers must, if they see their task in its true perspective, assume the responsibility not only of creating improved production facilities but also of operating them.

The limited conception of the field of engineering held by engineers in general is due in no small part to the influence of the technical school. No one questions the high sense of duty and the devotion of engineering educators, but because of the limitations imposed by inadequate financial resources, the absence of the human factor in laboratory and classroom exercises and the detachment of college environment from affairs of the world, the technical school has been unable to construct a curriculum that reflects the larger ideals of engineering as expressed in the opening paragraph. Lacking a real engineering setting and having no direct need for consideration of those economic and human factors which enter so largely into the practice of engineering, the technical school has to a large degree ignored them in its treatment of engineering subjects. Gradually the curriculum has been developed around the idea that proficiency in the solution of mathematical and scientific problems constitutes the proper initial training for engineering work. Unquestionably the preparation for theoretical and material problems of the engineering profession has taken precedence over the larger task of developing the fundamental qualities of leadership not only from the reasons mentioned above but also from the belief that knowledge of practical affairs is to be acquired in practice after graduation. Allowing for the fact that experienced teachers can and do mold the most rigid curriculum into practical and inspiring forms, we cannot avoid the conclusion that the conventional scheme of technical training, as organized and applied, tends to produce technical advisors rather than engineering leaders.

Industry absorbs the bulk of engineering talent and young men entering this field of endeavor must be prepared for exceedingly complicated tasks, involving, in addition to mathematics and science, a thorough knowledge of economics, of production and of men. Technical courses taught on the basis of pure theory without reference to the latter factors certainly do not meet the need of a large majority of young engineers for conditions confronting them at this time.

Without lowering in any degree the pressure on fundamental theory, instruction must emphasize the importance of the factors of time, cost, production, safety, and of the human element. Even the fundamentals, mathematics and science, must be given new life by teachers who look at these subjects as tools of the engineer, instead of as academic exercises for training the mind.

The Scope of the Engineering Field

The field of engineering is broad in scope and purpose. It calls for an increasing force of trained men to perform a multitude of diversified services. Notwithstanding appeals for men with particular training, the technical school cannot attempt the preparation of engineers for special tasks. It must seek to promote knowledge of engineering fundamentals to the exclusion of technical skill required in specialized branches of engineering and of industry. But the presentation of fundamental matter should be governed, as previously suggested, by the needs of present engineering practice rather than by traditional academic considerations. It goes without saying that all will not agree with this proposal to liberalize present curriculums. The reasons formerly considered as fundamental are in opposition to the views expressed, but it is questionable whether the arguments employed to sustain them are entirely effective under present conditions.

We may consider the engineer as a technician or as an operator; we may carefully define his ideals and his tasks; we may prepare him for a certain type of service, but the composite result will be naught if our subject cannot produce and produce cheaply. Now the engineer is preëminently a producer, a producer of something useful to man, and it is obvious that his training must be organized to fit him for this task. The technical school is responsible for what is roughly the second training period, and if it fails to contribute its full share to the effective preparation of the engineer for the services demanded of him, we may expect the pressure of need eventually will force an adjustment in methods of training. To this, the ultraconservative will not agree, since to him it is a mistake to change the existing order. But educators are beginning to see more clearly that methods of training to be effective must respond to the developments in engineering practice, and also that a change in method necessarily does not effect a correct application of basic principles. In recent years technical education has undergone a number of striking modifications, which indicates a growing effort on the part of the technical school to keep pace with developments in engineering practice. Among these we note: Direct coöperation of technical schools and industry in administering joint courses of instruction; establishment of specialized courses in technical schools for employees of engineering and industrial concerns; organization of post-graduate courses with highly technical aims by industrial concerns with the assistance of the technical school; establishment of new colleges of industrial organization, commercial engineering, chemical engineering, ceramic engineering, operation and management, etc.; introduction of courses covering a wide variety of technical subjects; and lastly, the promotion of a closer working relationship between practicing engineers and the technical school. These developments have not lowered the status of engineering education; on the contrary, they have greatly enlarged the usefulness of the technical school and brought to it a larger measure of support from those interests directly concerned with engineering affairs.

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[1] Manager of Shop Laboratories, University of Illinois.

Abstract of a paper presented at the Indianapolis Mid-West Sections Meeting of The American Society of Mechanical Engineers, Oct. 24 and 25, 1919.

While progressive educators recognize the fact that technical education is entering upon an era of more effective service, they are not agreed as to definite lines of development. With a problem so complex as this, agreement as to policies and details should not be looked for; in fact, concurrence of views in respect to this matter is an impossibility from every standpoint. The cause of technical education will be advanced most rapidly by the development of distinctive policies and a frank exchange of ideas about them. It is this thought that prompts the effort to describe the plan of training engineers in the principles of industrial management at the University of Illinois. Although it is recognized that a large majority of engineering graduates enter industrial work, a special course of study for training engineers in industrial management has not been established at this institution. This policy may be modified in the future, but the belief still prevails that the best preparation for the practice of engineering, in all branches, is a thorough grounding in the fundamental subjects of mathematics and of science, coupled with a certain amount of specialization in particular engineering subjects. The main engineering courses seem to satisfy, for the time at least, these general requirements. Consequently no attempt has been made to provide a special curriculum for men expecting to enter industrial work. On the other hand, it was felt that engineers should be given definite training in the principles underlying the management of men engaged in productive enterprises, which led to the adoption of a new policy in administering the traditional shopwork courses.

THE COMMERCIAL ORGANIZATION OF TECHNICAL-SCHOOL SHOPS

It is not the intent of this paper to discuss the changes in methods and ideals which have been made in the shop courses at the University of Illinois, as these possess little interest in comparison with the more vital topic: What is being done now and with what results? The plan is a practical application of the theory of engineering as expressed in the opening paragraph. It recognizes the engineer primarily as a manager of human enterprises rather than as a technician making plans for others to execute. And again the plan represents the new spirit in engineering education of which mention previously was made, as it was developed on the theory that training for engineering tasks must join with the study of fundamental subjects, actual experience with processes of production. To provide a medium for carrying out the latter part of this program, in the year 1912 the shop laboratories were organized on the lines of a commercial plant for manufacturing gas engines. The plant consists of five departments: pattern, foundry, forge, machine, and assembly. Each department, except the latter, is in charge of a superintendent who is responsible for both operation and instruction. An assistant superintendent, mechanics and toolroom attendants complete the departmental organizations. An assistant manager looks after plant operation. Final authority on all matters is vested in the office of manager, who is responsible to the head of the department of mechanical engineering. The instructional staff serves as a shop committee and acts in an advisory capacity on important matters.

In the plant itself the most effective production methods within the existing limitations are in use or being installed. All shop operations are standardized and covered by detailed instruction cards. Jigs and fixtures and special tools are generally employed. Machinery is effectively grouped and maintained in operating condition, and equipped with safety guards and devices. Modern tool stockrooms with stocks of standard tools and supplies are maintained in each department. Approved methods of routing, dispatching, inspection, and transportation of parts are effective throughout the plant. Control and storage of materials is effectively carried on by accepted methods. In respect to methods and facilities for the production of work, the shop laboratories may be considered as representative of the better type of small commercial plants manufacturing similar products. It has been the aim to duplicate the form of the commercial manufacturing plant along with its problems of organization, production, and management. This result is not secured in all respects since the actual industrial environment is lacking, but the essential requirements of a production laboratory are established in quite definite form. In effect, the University of Illinois has a manufacturing plant, equipped with facilities, methods and materials for the production of a useful product, but without an operating organization. The latter is supplied from the ranks of students specializing in mechanical, electrical and railway engineering during their sophomore and junior years.

This group at present numbers approximately 500 men. It is untrained, but in the aggregate it represents a wealth of human talent. The instructional plan is a simple one of training this group of embryo engineers to operate the plant and produce gas engines efficiently and economically. Production is sought not for the usual commercial reasons, but as a laboratory exercise for training men in the principles of management and in the mechanical processes of production. The aim is to stimulate the spirit of leadership by placing the responsibility of operation squarely before the student. In this feature, the plan departs from the usual method of academic instruction, and in a considerable degree it fulfills the requirements previously mentioned for training that will develop leaders rather than technicians.

THE DEVELOPMENT OF THE INSTRUCTIONAL PLAN

Essentially the industrial process is a simple one of changing materials from one form to another by the application of power through the agency of tools, under human control and direction. Specifically, the instructional plan is developed around the theory that preparation for industrial management is accomplished through a study of the three important elements of the industrial process just mentioned: (*a*) the worker or the producing unit; (*b*) the equipment or the unit worked with; and (*c*) the materials or the unit worked upon. The meaning of these basic elements and their relation to each other is brought out by treatment of the following topics under three headings:

The Worker. Types of organization, functions of the executive, relations to industry, physical facts, effects of environment, methods of reward, costs of service.

The Equipment. Selection and specifications, maintenance methods, operation methods, planning methods, production methods, standardization methods, testing and experimental methods, and costs of production.

The Materials. Studies in construction and suitability, purchasing methods, storage methods, dispatching methods, ordering and inventory methods, transportation and delivery methods, costs of materials.

As arranged, these topics form a syllabus of the course of instruction, which has determined the details of the practical working plan, a brief description of which follows.

THE CLASSIFICATION OF THE STUDENT BODY

The entire body of students previously referred to is automatically divided by registration into four groups, one to each of the main departments of the shops. Each of the department groups is subdivided into staff assistants and shop workmen. Assignments to these duties are made arbitrarily. but each student is moved periodically from one task to another so that during the entire course he performs all of the staff functions and the required mechanical, or shop, operations. The schedule is arranged so that the time is divided equally between the staff and shopwork. Duty assignments are for periods of two weeks or four weeks, depending upon the work to be covered, and they are alternated between the office and shop, according to expediency. From the performance of the duties of production assistant, a student, in the foundry, for instance, may be found during the following work period making molds of pistons on one of the molding machines, or vice versa. At the beginning of the term demonstrations of shop operations and of staff duties are given to all students, which are expected to prepare them for any subsequent work they may be called upon to do, with the aid of carefully prepared standard practice instructions.

The staff group performs the executive and supervisory work of the plant, and the shop group serve as workmen at the bench, on machines, in the core room, at the hardening furnaces, or wherever their services are required. Job orders are issued by the staff group to the shop group, according to the requirements of the production schedule adopted at the beginning of the school term. There are four sections of students in each department operating independently on different periods of the week, which introduces considerable rivalry in the matter of output. Naturally those sections with the most effective staff work secure the greatest production and the highest shop efficiency.

There are seven distinct divisions in the staff work: production, safety, standard practice, materials, mechanical, experimental, and accounting. Every student is expected to serve the allotted time in each division, but only once throughout his entire shop course. He may obtain his training in production, for instance, in the foundry, and in standard practice after entering the machine department. He will perform, however, all of the staff functions before completing his shop course.

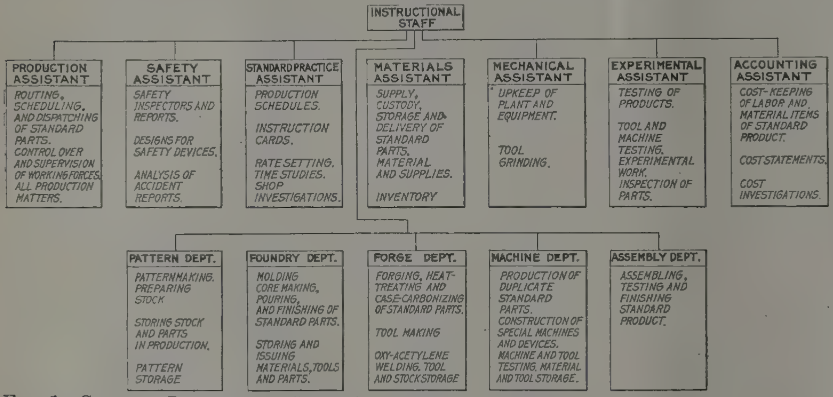
INSTRUCTIONAL STAFF
PRODUCTION ASSISTANT
ROUTING, SCHEDULING, AND DISPATCHING OF STANDARD PARTS.
CONTROL OVER AND SUPERVISION OF WORKING FORCES.
ALL PRODUCTION MATTERS.
SAFETY ASSISTANT
SAFETY INSPECTORS AND REPORTS.
DESIGNS FOR SAFETY DEVICES.
ANALYSIS OF ACCIDENT REPORTS.
STANDARD PRACTICE ASSISTANT
PRODUCTION SCHEDULES.
INSTRUCTION CARDS.
RATE SETTING. TIME STUDIES. SHOP INVESTIGATIONS.
MATERIALS ASSISTANT
SUPPLY, CUSTODY, STORAGE AND DELIVERY OF STANDARD PARTS.
MATERIAL AND SUPPLIES.
INVENTORY
MECHANICAL ASSISTANT
UPKEEP OF PLANT AND EQUIPMENT.
TOOL GRINDING.
EXPERIMENTAL ASSISTANT
TESTING OF PRODUCTS.
TOOL AND MACHINE TESTING.
EXPERIMENTAL WORK.
INSPECTION OF PARTS.
ACCOUNTING ASSISTANT
COST-KEEPING OF LABOR AND MATERIAL ITEMS OF STANDARD PRODUCT.
COST STATEMENTS.
COST INVESTIGATIONS.
PATTERN DEPT.
PATTERNMAKING. PREPARING STOCK
STORING STOCK AND PARTS IN PRODUCTION.
PATTERN STORAGE
FOUNDRY DEPT.
MOLDING CORE MAKING, POURING, AND FINISHING OF STANDARD PARTS.
STORING AND ISSUING MATERIALS, TOOLS AND PARTS.
FORGE DEPT.
FORGING, HEAT-TREATING AND CASE-CARBONIZING OF STANDARD PARTS.
TOOL MAKING
OXY-ACETYLENE WELDING. TOOL AND STOCK STORAGE
MACHINE DEPT.
PRODUCTION OF DUPLICATE STANDARD PARTS.
CONSTRUCTION OF SPECIAL MACHINES AND DEVICES.
MACHINE AND TOOL TESTING. MATERIAL AND TOOL STORAGE.
ASSEMBLY DEPT.
ASSEMBLING, TESTING AND FINISHING STANDARD PRODUCT.

Fig. 1 General Layout of Shop-Management Courses for Engineering Students

Showing organization of student operating staff and the main features of the training in executive and administrative work; the main shop departments and the most important items of training in mechanical shop practice.

The Work of the Students

The required work in each staff division is shown by the diagram of Fig. 1, a study of which, it is believed, will substantiate the statement that the various items are fundamental in the training of engineers for the practice of industrial management. In general, the student obtains from this part of the course a rather definite impression of routing and dispatching parts through the shop, standardizing work operations, rate setting, the custody of materials and supplies, safeguarding dangerous equipment, upkeep of machinery and tools, inspection of parts, cost keeping, as well as the supervision of men engaged in the production of work.

For the conduct of staff functions, effective but simple systems embodying the use of shop records, forms and production facilities have been adopted in somewhat different detail by the various departments. Production boards are employed in this work, and the effect of graphical records such as this upon the more intelligent students is very marked. Those with inborn executive ability immediately display their special qualifications for organization and leadership by increasing output over less gifted predecessors. The records of this group of students are repeated in all departments. There is no doubt about them; they are born to lead, and they do lead, although they may not measure up to the highest academic standards in other courses.

The Departmental Organization

Departments are organized on similar lines and they administer instruction after a common plan, but the difference in character of their mechanical processes, and of the materials used, makes it possible and also advisable to vary departmental emphasis on certain features of the instruction. In the pattern department the subject of planning and work analysis is given special consideration; in the foundry and machine departments production of parts is emphasized; and in the forge department experimental work is given prominence. By this arrangement the more important factors of shop management are brought forcibly to the student's attention. As the time allotted to the shop courses is entirely inadequate for a thorough presentation of the subject of industrial management, instruction is planned to throw the important elements into bold relief with the object of creating lasting impressions of them upon the mind of the student. It follows that certain features of the work, which were formerly considered of some importance, are given no more than passing attention, but this is immaterial if the larger principles of management are effectively presented to, and thoroughly understood by, the group of future leaders.

Charts, diagrams, graphical records, and illustrations of all kinds are freely employed throughout the various stages of the instruction. It has been clearly demonstrated that facts and impressions are more easily and accurately acquired through the eye from illustrations than by any other method. In addition an effective graphical representation appeals to the imagination and stimulates the desire to work and to produce results.

As the object of the course is the training of engineers in the principles of management, the staff portion of the instruction is strongly emphasized, but not to the exclusion of the other portion relating to manual shop-work. The time devoted to each of these phases of plant operation is divided equally. A general idea of the manual operations performed during the entire course will be gained by referring to the diagram of Fig. 1. Briefly, this work includes patternmaking and preparing stock, molding, core making, pouring metals, and finishing castings, forging, heat treating and case carbonizing, machine-tool operation, assembling, finishing and testing. All of these operations are performed on standard gas-engine parts. Operations are standardized as to method and time. Jigs and special tools are employed wherever they apply. Jobs are scheduled by a staff assistant according to the production program, so the student workman must produce a given volume of work that will pass inspection if he obtains a passing grade in the course. A record of actual time on each operation is recorded by time clocks on job orders. The ratio of this time to the standard time allowed by the instruction card gives the efficiency of production of individuals on separate jobs. No attempt is made to teach students the so-called fundamental shop operations. Machine and tool operation is explained, and accurately prepared instructions for doing single jobs are issued, from which the student is expected to go ahead and produce. Generally, it may be said, that the average student does this in satisfactory fashion.

The above-mentioned plan is not perfect. Its faults, however, are superficial rather than fundamental. It is not intended to fulfill the specifications of a complete course in industrial management, nor is it expected to possess the power of developing competent executives and managers from untrained men within the period of a few weeks; but as a pioneer experiment in technical education it presents possibilities of usefulness in the development of engineering leadership which, it is hoped, will be fully realized.

Alloyed Aluminum as an Engineering Material

By G. M. ROLLASON,[1] CLEVELAND, OHIO

Upon its discovery aluminum was hailed as a panacea for all the ills of the metallurgist and its use was proposed for every imaginable purpose from armor plate to chemical chambers. But because it failed to do all that was expected of it a general distrust was created which has been very hard to live down. Recent developments, however, especially those which took place during the war, are rapidly dispelling this idea. In his paper the author first treats of unalloyed aluminum and its light alloys. He traces the improvement in the development of commercial alloys, presenting in connection therewith photomicrographs of the alloys commonly used. He also discusses the subject of the casting of aluminum as well as the methods employed in both the cold and hot rolling of the metal. The possible future uses of aluminum and its various alloys are also briefly considered by the author, who ventures the opinion that perhaps it would not be too optimistic to say that while we have passed through the Stone Age and the Bronze Age, and are now living in the Iron Age, that the future holds in store for us an Aluminum Age.

THE physical properties of aluminum which render it useful for certain general applications are well known, but its special properties and more particularly those of its alloys which render the metal useful for strictly engineering purposes are not, however, so thoroughly understood as the present diversified uses in engineering would seem to imply. At the same time, as is natural during the development of a comparatively new material, there is a tendency to expect sometimes too much and sometimes not enough.

Attempts to use aluminum under unsuitable conditions, however, are not now as prevalent as they were ten years ago. It should nevertheless, be realized that the possible field of application is limited by the specific properties of the metal. Aluminum and its alloys have their true field just as clearly indicated by their properties and price as are the fields of copper and its alloys or iron and its alloys. A consideration of the fields of application where manufactured aluminum has found its way by natural growth and scientific development will indicate those fields where its application is most legitimate.

Fig. 1 shows both the annual production of aluminum metal in the United States from 1895 to the beginning of the war period, and the total number of motor vehicles produced yearly through a period over which the increase of aluminum production has been very marked. The world's total annual aluminum production at the present time may be estimated about 300,000,000 lb.

During the war period development of aircraft was of course responsible for considerable increase in the application of light alloys. The parallel growth in the two production curves confirms the actual facts in that a very large percentage of aluminum production finds its way into automotive vehicles, which is by far the greatest field for engineering application of the metal. It is to be expected, however, that development of aerial navigation in the future will take a very large share of the increased light-alloy production.

Unalloyed Aluminum

The characteristic and dominant properties of aluminum are of course very well known, the most important being its low specific gravity. Next in importance come the relatively high conductivities, both thermal and electrical. This is true not only of the commercially pure metal, but of its light alloys, that is, those containing aluminum as their principal ingredient. In these the properties of aluminum itself, such as specific gravity and conductivity, are dominant, but the mechanical properties can be very greatly improved by alloying.

The engineering applications of the commercially pure metal are fairly limited and somewhat beyond the scope of this paper, but the physical properties of the pure metal are interesting as a basis of comparison for those of the alloys. In the cast or annealed conditions these properties are:

Tensile strength	13,000 lb. per sq. in.
Elongation	25-35 per cent
Modulus of elasticity (Cast iron, 20,000,000; machined steel, 30,000,000)	8,500,000-10,000,000 lb. per sq. in.
Brinell hardness	25
Sclerescope hardness	5-6
Specific gravity	2.7
Specific electrical conductivity	61 (copper, 100)
Specific thermal conductivity at 64 deg. fahr.	116 (copper, 222)

Extreme ductility and softness make figures for compressive strength meaningless.

The commercially pure metal in the cast condition has practically no engineering application. In the wrought or cold-worked state, however, there is of course a very large commercial use. Domestic use of spun, stamped, or rolled aluminum ware is very familiar and the characteristic lightness and heat conductivity are again the controlling properties.

Rolled aluminum sheets and drawn wire are also in extensive use. The rolled sheet is used largely in automobile bodies, gasoline tanks, etc., where the improvement in properties due to working is utilized for mechanical strength, rigidity, etc. The metal is rolled hot at about 400 deg. cent. from the ingots or slabs to a sheet ¼ in. to ⅜ in. thick and further reduction down to gage thickness is done by cold-rolling. Annealing of cold-worked aluminum, that is, recrystallization, will take place slowly at around 200 deg. cent., but for practical purposes the range is around 350 deg. cent. and higher. In addition to the rolled sheet, stamped or pressed aluminum is used in the automobile industry for fenders, beading, hoods, etc., and has found some application in airplanes and dirigibles for parts subjected to light stresses. There are, however, alloys of aluminum which are of much greater importance and possibilities than the pure metal, in particular duralumin, which will be referred to later.

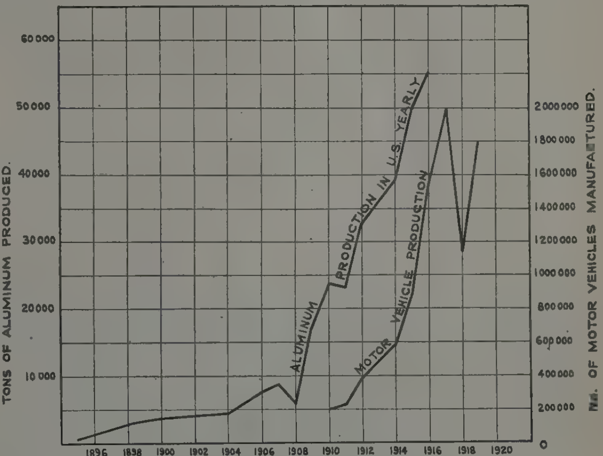

Fig. 1 Parallel Growth of Aluminum and Automotive Industries

Hard-drawn aluminum wire is used to some extent for transmission of electrical power, particularly in Europe, and by virtue of the combination of high conductivity and specific gravity. The following is a comparison of copper and aluminum wire:

	Copper	Aluminum
Specific conductivity	100	61
Cross sectional area for equal conductivity	100	164
Weight for equal conductivity	100	50
Tensile strength of hard-drawn wire	60,000	28,000

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[1] Aluminum Castings Co.

Abstract of a paper presented at a meeting of the Metropolitan Section of The American Society of Mechanical Engineers, February 10, 1920.

Specific gravity........................	8.9	2.7
Specific tenacity........................	6,740	10,400

The last figure, specific tenacity, is an index of comparison which has been used to some extent by English metallurgists. It simply amounts to expressing strength in terms of weight, and the figures quoted are the unit tensile strength divided by the specific gravity. The term was developed in order to provide a reasonable index of comparison for useful light alloys with more common materials. The commoner industrial metals, iron, copper, zinc and nickel, for instance, have so nearly the same specific gravity that their tensile strength can be compared section for section, but where the section can be enlarged for equal or better strength with saving in weight it is necessary to get down into more strictly comparative terms. The substitution of aluminum wire for copper has of course been influenced by the relative market prices of the two materials and has only been extensive during periods when the copper market was abnormally high.

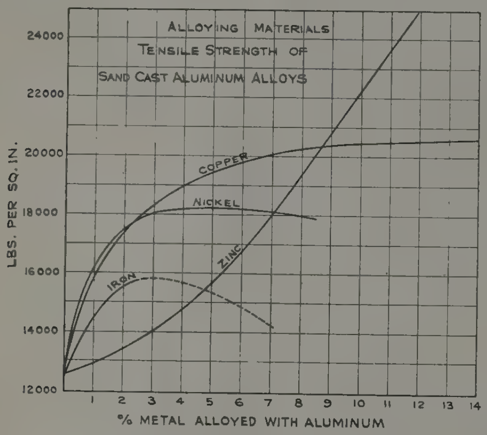

FIG. 2 TENSILE STRENGTH OF SAND-CAST BINARY ALUMINUM ALLOYS

With normal market conditions of the two metals, a price of 15 cents per pound for copper corresponds to 25 cents per pound for aluminum. In cases where aluminum can be substituted bulk for bulk the possibilities for the application of aluminum are therefore very obvious. There are some other applications of the unalloyed metal; for instance, aluminum is worked hot by extrusion under hydraulic pressure, the temperature used for this being about 400 deg. cent. It is fabricated in this way into structural shapes, rods and tubes, and sections up to 6 in. in diameter with wall thicknesses as small as 1/8 in. have been made. Continuous tubing may also be made by this method. This tubing finds some application in pneumatic conveyors for department-store service, also in the chemical industry where, for resistance to certain types of corrosion, the commercially pure metal gives a very satisfactory performance.

LIGHT ALLOYS OF ALUMINUM

The possibilities for engineering application of aluminum alloys are due to the fact that the lightness of aluminum can be combined in the alloys along with marked improvement of mechanical properties such as tensile strength. The term "light alloys" is one which has been finding favor during the past few years, particularly in connection with war work, and may be said to embrace those alloys having aluminum as their base and whose specific gravity ranges from 2.65 to 3.0. This division is purely arbitrary, but it is interesting to note that when there is enough heavy metal in the alloy to give a specific gravity higher than 3, the mechanical properties at the same time change to such an extent as to render the material unsuitable for many engineering purposes. The alloying of a metal lighter than aluminum, such as magnesium, will bring the gravity down below 2.65, but there are not many alloys in use where magnesium is alloyed in such an amount as to bring the gravity down without simultaneous additions of other heavier metals to produce a counteracting effect. The outside limits for aluminum alloys in commercial use are set on the light end by an alloy containing 5 per cent magnesium, with specific gravity of 2.47, and on the heavy end by an alloy containing 33 per cent zinc, with a specific gravity of 3.3.

Commercial aluminum always contains iron and silicon in amounts ranging from 0.25 per cent and upward according to the grade of ingot, and while there is a tendency to regard iron and silicon as impurities, nevertheless by their judicious control they can be made to act as useful alloying ingredients.

The commoner metals which are used to alloy with aluminum are copper, zinc, magnesium, and nickel. There are many others which have been used in aluminum-base alloys, most of which, however, have hardly passed the experimental stage. Among these may be mentioned chromium, molybdenum, tungsten and vanadium. In general the effect of progressive additions of the alloy metals to aluminum is to render the base metal correspondingly harder, stronger, and less ductile. It should be explained that "ductile" does not refer here to the property of being easily drawn into wire, but merely to the measured percentage elongation, that is, the amount of possible deformation without fracture.

Three types of aluminum alloys are manufactured for engineering purposes, namely,

1 Casting
2 Cold-working
3 Forging or hot-working.

It is estimated that a half of the world's production of aluminum goes into castings, that is, it is used in the alloyed form, and since a large part of the unalloyed aluminum is put to miscellaneous and non-engineering uses, the majority of engineering uses and mechanical applications must consist of castings. The casting alloys will therefore be considered first.

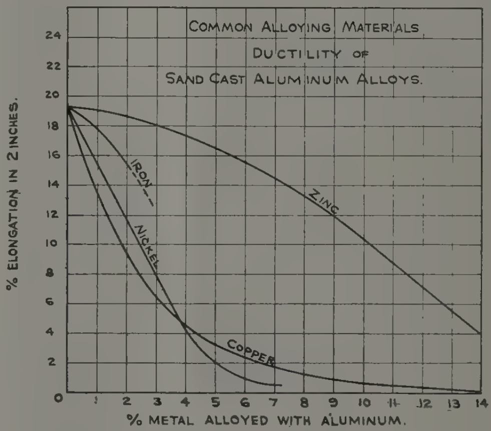

FIG. 3 DUCTILITY OF SAND-CAST BINARY ALUMINUM ALLOYS

DEVELOPMENT OF PROPERTIES BY ALLOYING

Figs. 2 and 3 show the variation in tensile strength and ductility of aluminum, cast under carefully controlled conditions, produced by progressive additions of copper, zinc, nickel, and iron as alloying ingredients. Copper gives increased strength and decreased ductility up to about 11 per cent, at which point the alloys become quite brittle. The effect of zinc is less marked than that of copper in amounts up to 8 per cent especially as regards ductility; above 8 per cent the zinc alloys continue to become stronger and less ductile after the effects of copper have practically reached their maximum. This difference in behavior of copper and zinc alloys is due to difference in structure. (See later paragraphs under the heading Metallography.) Iron gives useful strengthening properties in amounts up to 2 per cent, but above that the effects are doubtful owing to rapid rise of the melting point and other disturbing conditions. This effect of iron, unlike that of the other metals, is additive, that is, it can be superimposed on that of the other metals. Nickel in behavior is intermediate between copper and iron.

Magnesium is a valuable addition to aluminum or its alloys when used judiciously. Of all metals it has perhaps the most pronounced effects on the properties of aluminum when added in small amounts, probably owing to presence of silicon. It is a very pronounced hardener and especially if the silicon content of the aluminum ingot is high the effect of magnesium even in amounts as low as 0.1 per cent will be to render the alloy stronger, harder and more brittle.

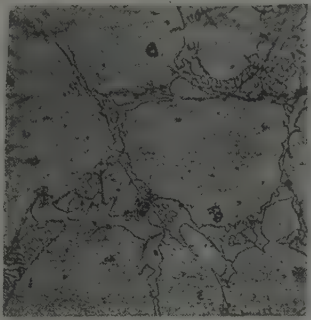
Fig. 4 Typical 8 Per Cent Copper-Aluminum Alloy

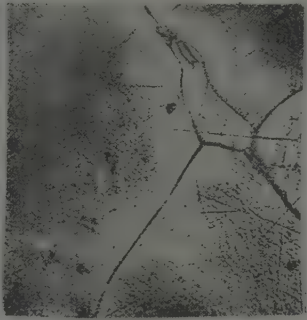
Fig. 5 Typical 15 Per Cent Zinc-Aluminum Alloy

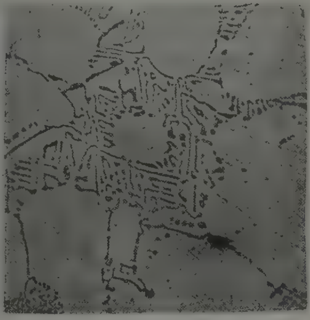
Fig. 6 Aluminum Alloy Containing Mg_2Si Compound

When about 12 per cent of copper or 15 per cent of zinc is added, the specific gravity reaches about 3 and it will be noted that when this figure is reached the alloy has reached a state of comparative brittleness and low ductility which renders it not only of limited usefulness in the cast state, but incapable of being cold-worked. It will be seen that it is comparatively easy to choose mixtures for alloying composition which will give high tensile strength, but to obtain a combination of high strength and ductility it is necessary to use careful selection and to give attention to constitution. The most important alloying materials are copper and zinc; that is, for casting and working purposes aluminum-copper alloys, aluminum-zinc alloys and aluminum-copper-zinc alloys cover most of the field. At the present time the aluminum-copper alloys find a good deal of favor in this country, while aluminum-zinc alloys seem to be preferred in Europe. This condition, however, has changed from time to time, since there have been periods when aluminum-zinc alloys have been in extensive use in this country. It is probable, as investigation and development progress, that successive improvements will involve more complex mixtures.

Metallography of Aluminum and Its Alloys

While the development of alloys, particularly casting alloys, in the past has been more or less a matter of cut and try, the metallography of these alloys is becoming quite well understood and study of constitution is leading to the development of properties in light alloys which have not been brought out through many years of experiment under the older methods.

Fig. 4 shows a micrograph of a typical 8 per cent copper-aluminum alloy. It contains two constituents, one being the background or matrix of solid solution, that is, so-called mixed crystals of copper dissolved in aluminum; the other constituent which appears as a network around the grain boundaries is a eutectic of the solid solution and a compound $CuAl_2$. This network is very hard and brittle and serves to reinforce the alloy, making it harder and stronger. At high temperatures, just below the melting point, the solid solution will contain about 4 per cent of copper. In an alloy like this, with 8 per cent copper, the other 4 per cent goes to form the eutectic network around the grain boundaries. It is to be noticed that the network is quite complete, that is, it forms a closed structure, and since it is brittle it cuts down the ductility of the alloy, which in this case shows only about 1½ per cent elongation. Though the solid solution is more ductile and would show more deformation without break, the brittle eutectic network prevents it.

Zinc, as shown in Fig. 5, is more soluble than copper and the solid solution will contain about 40 per cent of zinc without the appearance of a separate constituent. In general appearance this alloy is quite similar to pure aluminum. The effect of the zinc is to make the crystals of solid solution stronger, but there is no separate brittle constituent with cellular structure as was the case with copper so that for a given tensile strength the zinc alloy will have a greater elongation. Fig. 6 shows the appearance of magnesium. The magnesium will form a solid solution up to a certain point and then separate out, a compound Mg_4Al_3 being formed, but since all aluminum ingot contains silicon, the result is generally somewhat different. The magnesium combines with silicon to form a compound Mg_2Si, which is practically insoluble and very brittle. Its effect is the same as that of the copper compound, but very much more pronounced; that is, an addition as low as 0.25 per cent magnesium has a marked hardening effect.

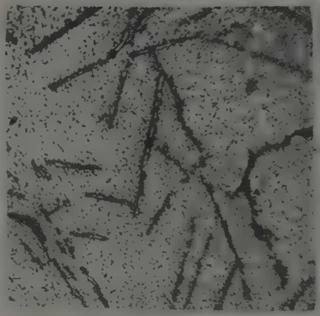
Fig. 7 Aluminum Alloy with Needles of $FeAl_3$ Compound

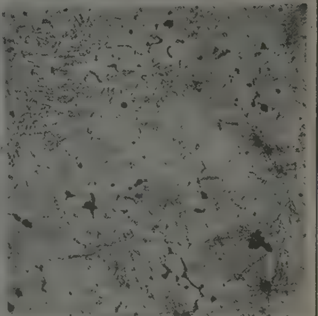
Fig. 8 Aluminum-Copper-Zinc-Iron Alloy

Iron, manganese, and nickel form compounds with the aluminum such as $FeAl_3$, which show up in the form of long needle-shaped crystals as in Fig. 7. These compounds are practically insoluble, and even a small amount of iron will cause the appearance of the needles. The effect of these needles is to break up the continuity of the copper or other network, and in the case of a break the iron needles make the path of rupture longer. In this way small additions of iron give both greater strength and greater ductility.

Fig. 8 shows a ductile casting alloy containing copper, zinc, and iron. The zinc does not show up, since it stays in solution. The copper network is just beginning to appear, since there is about 3 per cent copper present, or just in excess of the amount which will stay in solid solution under the normal cooling conditions. The iron needles are distributed around and perform their function of giving additional strength and ductility.

Commercial Casting Alloys

The development of useful physical properties by alloying selected metals with aluminum has made possible the commercial use of a number of widely varying alloys. A good many of these are either straight binary alloys or binary alloys with very slight impurities or additions of third or fourth metal. The light aluminum alloys which are used for sand casting in America center for the most part around different copper-aluminum combinations.

The principal aluminum alloy used for castings in the United States consists of about 92 per cent aluminum and 8 per cent copper, and is generally known as Aluminum Company of America's No. 12 alloy or S. A. E. specification No. 30. This alloy when cast in a ½-in. test bar in green sand and tested without machining off the skin should give an average tensile strength of about 20,000 lb. per sq. in. and an average elongation of about 1.5 per cent in 2 in. A modification of this alloy having somewhat better physical properties is now finding considerable favor in castings for the automotive industry. This alloy has an analysis of 7.5 per cent copper, 1.5 per cent zinc, 1.2 per cent iron, and the remainder aluminum. The tensile strength of this alloy will average about 21,000 lb. per sq. in. and the elongation will be somewhat greater than that of the No. 12 alloy.

Where greater ductility is required the copper content is cut down to about 5 per cent, resulting in a tensile strength of about 18,000 lb. per sq. in. and an average elongation of 3 per cent. This alloy is used for castings such as those for automobile bodies which require to be pressed or bent into their final shape. This alloy is somewhat more difficult to cast than No. 12, due to the lower copper content and consequently higher shrinkage.

Another alloy which is well known under the designation S. A. E. Specification No. 32, contains approximately 12 per cent copper and remainder commercial aluminum. The high content of copper renders it somewhat easier to cast, as it cuts down the solidification shrinkage of the alloy and makes in general for denser and sounder castings. As a result of this the alloy is selected for use in castings where tightness against leaking is the principal requirement. It has the disadvantage of being quite brittle, due to the large amount of copper constituent present. The casting fails to show a marked improvement in tensile strength over the common 8 per cent copper alloy owing to the fact that in the structure of the latter the reinforcing network of copper compound is completely closed (See Fig. 4), and no further strengthening is produced by the excess amount given when the copper is increased up to 12 per cent.

As previously mentioned, there is a tendency in Europe, and especially in England, to favor the zinc-aluminum combinations, and the alloy which corresponds to our No. 12 is known as L-5 and contains 13.5 per cent zinc, 2.75 per cent copper and the remainder commercial aluminum. This has a specific gravity of about 2.95, or higher, which is relatively high as compared with No. 12 alloy at a specific gravity of 2.83. Its tensile strength when cast in sand is over 25,000 lb. per sq. in., but the elongation is not much over 1 per cent.

Another alloy which finds favor in England contains 10 per cent zinc and 2.5 per cent copper. Here some ductility has been gained over L-5, that is, it gives over 2 per cent elongation, but at a sacrifice of tensile strength, since the specification only calls for 22,000 lb. per sq. in.

The foregoing are some of the aluminum alloys most widely used in sand castings. There are, however, a few special uses which demand special alloys; for instance, commercially pure aluminum, in general, is much less subject to corrosion than any of its alloys, but in cast form is too soft for much practical use. In this connection an alloy of 98 per cent commercial aluminum and 2 per cent manganese finds some application, that is, it resists corrosion practically as well as the unalloyed metal, while the small addition of manganese gives the necessary strength and hardness in the castings.

Permanent-Mold Castings

By far the greater part of the cast aluminum used is in the form of ordinary sand castings, although a considerable tonnage of aluminum is manufactured in permanent molds. In this country the manufacturers of aluminum castings in permanent molds have not so far undertaken the casting of very large pieces, but castings up to 150 lb. in weight have been made in chill molds on a semi-commercial scale.

The chill-cast aluminum finds its principal outlet in the form of gas-engine pistons and this has led to the development of specialized alloys. Permanent molding, though a much newer art than sand casting, is susceptible of more scientific control and actually approaches a more exact science. The feasibility with which any alloy can be cast into a chill mold depends upon the simplicity of the desired casting design, and for casting complicated shapes the alloy selected should be such that its solidification shrinkage is relatively small.

For the permanent-mold casting of fairly intricate shapes such as aluminum pistons, bearing caps, etc., an alloy containing 10 per cent copper, 1.5 per cent iron and 0.25 per cent magnesium, remainder commercial aluminum, is used fairly extensively. This has the property of running well in permanent molds, the shrinkage being kept low by the relatively high percentage of copper. Fig. 9 shows the difference in structure obtained by casting this alloy in a permanent mold and in sand. It gives a fine-grained, dense structure with high strength and hardness, making it suitable for wearing or bearing surfaces and easy to machine. In a properly made chill casting this alloy will have a tensile strength of 28,000 lb. per sq. in. and 2 or 3 per cent elongation, but these properties can only be attained by careful attention to all the factors going to make up a good casting.

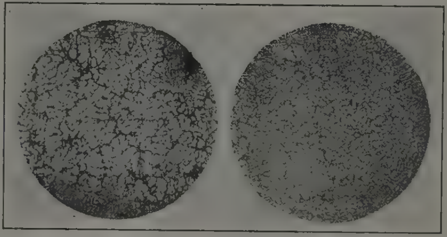
Cast in Green Sand **Cast in Permanent Mold**

FIG. 9 SAND- AND CHILL-CAST PISTON ALLOY

Table 1 enumerates the properties of some of the alloys whose composition has been given above.

TABLE 1 PROPERTIES OF CERTAIN ALUMINUM ALLOYS

	No. 12	S.A.E. 32	British L-5	Lynite 145
Tensile strength, lb. per sq. in.	20,000	20,500	25,000	27,500
Elongation, per cent	1.5	0.5	1.5	4.5
Brinell hardness	65	70	80	65
Scleroscope hardness	14	16	18-20	14
Specific gravity	2.84	2.90	2.92	2.89

Stress-Strain Characteristics—Value of Ductility

In the selection of a casting alloy for certain applications, ductility must rightly receive consideration. For parts which are subjected to normal stress, rigidity and a reasonable amount of strength are the only essentials. In many cases the factor of safety is also very high, since the dimension of the cast piece is controlled by ability to cast or manufacture—for example, the familiar aluminum crankcase casting. However, where a cast-aluminum member is designed for a heavily stressed part the resistance to normal stress is not the only matter to be considered. The factor of safety might be made such that the ordinary stress range could be taken care of, but if this were exceeded and there were no ductility in the material, complete failure would be the result. It is in connection with abnormal stresses in engineering parts and with abuse as opposed to normal use that ductility must be regarded as a very valuable and essential property for cast aluminum or similar engineering materials. There are also cases where, apart from the performance of the finished part, ductility is absolutely essential to the process of manufacture. Sand castings must of necessity have liberal tolerances for the dimensions. With these variations assembling of parts will involve some rough handling and knocking together and there are instances on record where assembling shops could not use the ordinary brittle aluminum alloys when it was attempted to substitute aluminum for bronze castings, but where a ductile aluminum alloy of high strength met with good success.

In general it may be said that the cast aluminum alloys are not very elastic materials, that is, if the proportionality of stress to deformation is considered to be the test of elasticity. However, though the proportional limit of cast aluminum alloys is low, the yield point is relatively high and in comparing the stress-strain curve of a cast aluminum alloy with that of machine steel, for instance (see Fig. 10), there is a range of relatively high stress, about 13,000 lb., for aluminum alloy and 34,000 lb. for the steel when both have taken on small amounts of permanent deformation, but at this point for further slight deformation of the aluminum alloy it is necessary to put on a relatively large additional stress, while the steel will deform greatly under quite a small additional stress.

The fatigue life of ordinary aluminum alloys under repeated reversal of stress (White-Souther test, for example) is not very well recorded. The performance, however, in such few tests as are on record seems very promising. There appears to be a safe working range well above the proportional limit. For instance, in ordinary No. 12 alloy the proportional limit is around 5000 lb. per sq. in. and tensile strength about 20,000 lb. per sq. in., but this alloy has shown a fatigue life of 16,000,000 reversals under a stress of 8500 lb. per sq. in. Machine steel, on the other hand, for a life of 16,000,000 cycles will take a stress of only 11,000 lb. per sq. in. when its tensile strength is over 60,000 lb. and its proportional limit correspondingly higher than that of the aluminum alloy. The fatigue properties of the aluminum alloys, however, are not thoroughly accounted for as yet, and while such results as the above have been obtained, there are only a limited number of them on record. In accounting for such performance it might perhaps be explained in terms of structure by the fact that the aluminum alloy is a combination of brittle and ductile materials, and whereas in the straight tensile pull the brittle materials are pulled out of place with a relatively small amount of total deformation and their strengthening effect is lost, under the reversal of stress in the fatigue test these constituents remain in their original position and the alloy retains the benefits of their presence.

POSSIBLE EXTENSIONS OF THE ENGINEERING APPLICATION OF ALUMINUM

The automotive field at the present time forms by far the largest engineering outlet for aluminum alloys. There are some possible applications which are based very specifically on the properties developed in aluminum alloys which may be mentioned, but these possibilities at the present time are not to any extent realized. For instance, in any kind of light high-speed machinery the inertia of reciprocating parts and consequent vibration and shocks can be cut down by judicious substitution of aluminum alloys for heavier materials provided their physical properties are properly understood and can be relied upon. Also in high-speed pulleys where centrifugal stresses run high, cast aluminum can be substituted for cast iron to good advantage.

Where rigidity is the prime consideration, the figures controlling the substitution of aluminum for ferrous materials are interesting. The modulus of elasticity of aluminum and its alloys may be taken as 10 million lb. per sq. in. with gray iron at 20 million and machine steel at 30 million. The rigidity is proportional to the modulus of elasticity and to the section modulus. To substitute aluminum for gray iron with equal rigidity, therefore, the section modulus must be doubled, and this can be done with a 50 per cent decrease in weight for a cross-section of equal rigidity.

THE WORKING OF ALUMINUM AND ITS ALLOYS

Aluminum alloys are not used to any great extent for cold-working. Cold-worked aluminum is nearly always unalloyed aluminum. The more ductile alloys are fashioned and shaped to some extent in the cold, for instance, in automobile body work, and during the war a very large number of fuse bodies for shrapnel were made by cold-stamping an aluminum alloy containing 3 per cent copper.

The rolling, drop forging and general hot-working of aluminum alloys have recently undergone considerable development and this has been largely due to development of particular alloys. At the present time the most remarkable alloy of aluminum is undoubtedly duralumin, which was developed in Germany by A. Wilm in 1903. A series of patents originating in Germany were brought out from the years 1903 to 1914. This alloy is notable for the fact that while it is fabricated in the hot condition, that is, well above the lowest annealing temperature, its final metallurgical condition and properties are controlled and improved by heat treatment and are very different from what the alloy composition gives in the cast or simple annealed form. Duralumin came into a good deal of prominence due to its extensive use in aircraft during the war. It was used to a large extent for framework and joints on dirigibles, being rolled and formed into structural shapes and extruded into tubes and sheets and a large number of other uses. The composition of the alloy varies somewhat, but the elements essential to the development of the characteristic properties are copper in amounts of 3.5 to 5.5 per cent and magnesium from 0.50 to 1 per cent. Additions are also made of such elements as iron or manganese in small amounts and even in some cases chromium or molybdenum.

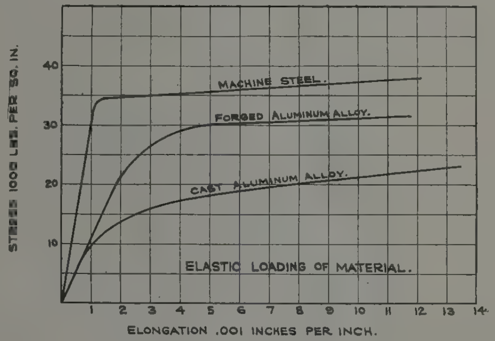

FIG. 10 STRESS-DEFORMATION CURVES OF ALUMINUM ALLOYS AND MACHINE STEEL

In the manufacture of duralumin parts the general cycle of operations consists of:

1 Pouring of the ingots
2 Hot-rolling to a slab or bar
3 Hot-working to the final shape
4 Heat-treating and quenching
5 Aging.

The ingots are poured with the metal at as low a temperature as possible, that is to say, just enough above the melting point to prevent cold shuts, a special type of tilting ingot mold being used. The ingot is then hot-rolled to a slab or bar for final working, the temperature being kept with advantage pretty close to 500 deg. cent. The final fabrication may be made by hot-rolling, hot-forging, hot-stamping, etc., according to the nature of the shape it is desired to produce. These operations are carried out within a carefully controlled temperature range, between 450 and 500 deg. cent. and the material is carried to its final shape.

The hot-worked material is possessed of properties greatly improved over what would show in the cast ingot, but the full development of its usefulness is only obtained by a specific heat treatment. The alloy is heated to a temperature of 500 to 540 deg. cent. for a period of ½ to 1½ hr., depending upon the size of the piece, and immediately quenched in cold water.

After this heat treatment and quenching the properties are still further improved, but are not fully developed until a process of aging is gone through. During the aging the alloy takes on a further increase of tensile strength and elongation. This aging is analogous to what takes place with the cast aluminum-copper alloys, but its effect is much more pronounced. The very best properties can perhaps be produced after heat treatment by an artificial accelerated aging at elevated temperatures around 150 deg. cent. As an example of the manner in which the properties are developed by the various stages of manufacture, the following are fairly representative figures of an alloy of general duralumin composition: The chill-cast ingot shows a tensile strength in the neighborhood of 30,000 lb. per sq. in. and elongation below 8 per cent. After rolling, hot-forging and annealing, the tensile strength runs from 45,000 to 50,000 lb. and the elongation from 10 to 20 per cent. The exact balance between strength and ductility at this point depends upon the temperature at which the working is finished, that is upon the amount of cold work put on to the piece. After heat-treating at 500 deg. cent. or above and quenching, the properties show a marked increase: 55,000 to 60,000 lb. per sq. in. tensile strength, and 25 to 30 per cent elongation. On a freshly quenched piece these figures would not be so high, but they develop after aging for two or three weeks. If the heat-treated material is given an artificial aging by exposure to a temperature of 150 deg. cent. for 48 hr. the tensile strength will be from 2000 to 5000 lb. higher than what is obtainable by natural aging. Extensive investigations have been carried out at the United States Bureau of Standards and elsewhere on the structural and other reasons controlling development of properties by working, heat treatment and aging and a fairly satisfactory explanation has been arrived at. Metallographic considerations would show, that the changes brought about are due in general to the change in solubility of the copper-aluminum compound as the temperature is lowered from 500 deg. cent. to ordinary temperatures.

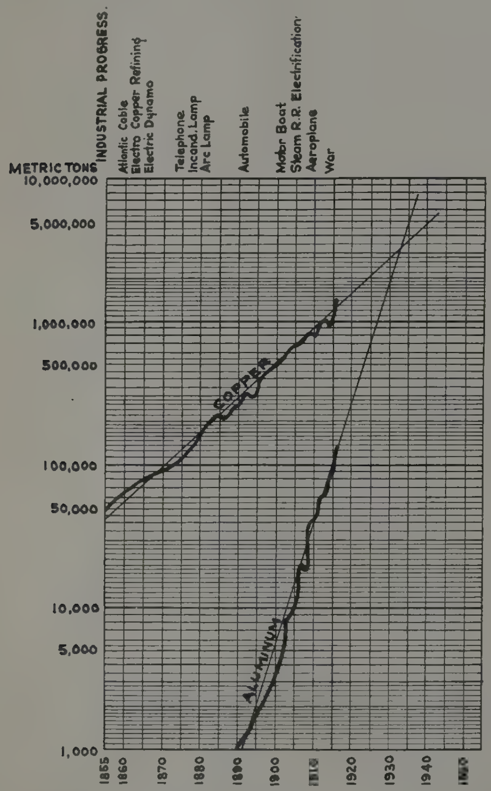

Fig. 11 World's Production of Copper and Aluminum Plotted Logarithmically to Show Relative Rates of Growth

The Applications of Duralumin

The possibilities for applications for an alloy of these properties and low specific gravity are of course very numerous. The rolling of structural shapes and of frameworks for permanent or portable structures has an immediate future. Drop-forged duralumin is finding its way into use in the automotive industry in the form of connecting rods, rocker arms, etc., as well as gears. Forged duralumin connecting rods have been submitted to prolonged test in special testing machines and in the motor on the block and on the road.

The fatigue life of the metal is very favorable indeed. A sample connecting rod made for use in a standard passenger car was run in a special machine consisting of a motor-driven crank and weighted crosshead. The speed was about 1500 r.p.m. and the load on the crosshead would correspond with about 50 per cent overload on the motor. The duralumin rod gave a life of 353 hr. and was still functioning when a casting on the crosshead failed in fatigue. A standard drop-forged steel rod for the same car showed a life of only 25 hr. under the same conditions, for example, with 50 per cent overload and another between 40 and 50 hr. at normal load both the steel rods failing in fatigue at the big end. The steel rod was of smaller section, but about double the weight of the forged aluminum rod. Some of these rods also have stood up well in block and road tests in the motor to the extent of over 10,000 miles of running. A notable feature of a number of these tests has been that at the big end bearing, the rod has been run direct on the crankshaft without any bushing whatsoever. Forged and heat-treated duralumin, in fact, is showing up as a very satisfactory bearing material when the wear is against a sufficiently hard shaft. Rods have been run against both case-hardened and heat-treated shafts. Owing to the relatively high expansion of the aluminum alloys, however, it has been found necessary to allow a little more end play at the big end bearings than is standard practice with steel rods.

The immediate future is going to tell considerably more about the actual performance of these and other applications of duralumin. Credit must be given the inventor of this alloy for having worked it out from fundamental scientific facts, and from the spectacular point of view this alloy represents a great achievement in developing properties in aluminum by alloying. In this case aluminum with a strength of 13,000 lb. has produced an alloy with a strength of over 60,000 lb. without loss of ductility, but the specific gravity has been increased less than 10 per cent. What other similar possibilities may lie in the future it is not safe to say, but let us remember the short space of time that has been spent in reaching even the present state of alloy development. A picture which is fairly familiar to the aluminum industry is that when we speak of the beginnings of iron or bronze or most other commercial alloys we go back thousands of years to prehistoric times, but when we speak of aluminum we go back as far as our own generation only. The abundance with which aluminum occurs in nature and the reception which the engineering world has given it insure a rapidly increased production for years to come.

Fig. 11 shows the history of the annual rates of production of copper and aluminum. By the use of logarithmic coördinates and by extrapolation the prediction can be made that somewhere about 1935 or 1940 the yearly production of aluminum will equal that of copper and afterward exceed it. Perhaps it would not be too optimistic to say that while we have passed through the Stone Age and the Bronze Age and are living in the Iron Age, the future holds in store for us the Aluminum Age.

Some Applications of Alloy Steels in the Automotive Industry

By H. J. FRENCH,[1] WASHINGTON, D. C.

The following paper deals with the application of various types of nickel-chromium steels in the automotive industry. Particular reference is made to the uses of steel containing 1 per cent nickel and 1 per cent chromium and also 3 per cent nickel and 3 per cent chromium. Data are also given for these two steels showing the tensile properties and hardness developed in small-size rounds subjected to varying heat treatments. A somewhat detailed mention is made of nickel-chromium steels and treatments used for gears and airplane-engine crankshafts. General specifications governing this latter part for both rotary and stationary engines are also given, and important difficulties frequently met with in the production of crankshafts are noted. "Streaks" and "temper brittleness," both encountered in the use of nickel-chromium steels, are briefly discussed and curves showing the tensile properties and hardness of "stainless steel" under varying oil-quenching and tempering treatments are presented. There are also shown the results of cutting tests made with cast high-speed-steel milling cutters and a comparison is given with high-speed cutters made by present-day ordinary methods. Micrographs are included to show the refractory nature of the carbide in cast high-speed steel.

ALLOY steels are very widely used in the automotive industry both in the manufacture of airplanes and automobiles, and without doubt have been one of the leading factors in the development of the industry. Adequately to present this subject, however, would require more space than is here available, and so this paper has accordingly been limited to a discussion of structural nickel-chromium and carbon-chromium steels. The results of a test of a cast high-speed steel cutter are also given because of the interest of all engineers in efficient cutting media.

Some common types of nickel-chromium steels having varied applications in automotive work are given in Table 1. The nominal percentages of the alloying elements are shown and the seven steels listed constitute a highly interesting series. They find use in production of such parts as axles, connecting rods, crankshafts, gears, steering knuckles, high-tensile bolts, and a variety of small parts either forged or machined from hot- or cold-rolled or drawn bars.

In general, as the alloy contents of this series increases more care in working and treatments is required, but under suitable conditions of manufacture a variety of properties may be obtained.

Steels containing nickel and chromium in the ratio of 2 to 1 seem to be in greatest favor, but any of the steels listed are capable of developing excellent combinations of strength and ductility greatly superior to plain carbon steels of similar carbon content. Steel No. 1, Table 1, will serve as a good example for discussion.

1 Per Cent Nickel and 1 Per Cent Chromium Steel

This steel, containing approximately 0.40 per cent carbon, 1 per cent nickel and 1 per cent chromium, was largely used in the production of various parts of a well-known rotary engine under widely different physical specifications. Three such parts with the tensile requirements and heat treatments used are listed in Table 2.

TABLE 1 NICKEL-CHROMIUM STEELS

No.	Carbon, per cent	Nickel, per cent	Chromium per cent	Ratio, Nickel to Chromium
1	0.10–0.50	1.00	1.00	1 to 1
2		1.25	0.60	2 to 1
3		2.00	1.00	2 to 1
4		2.50	1.25	2 to 1
5		3.00	1.00	3 to 1
6		4.00	1.00	4 to 1
7		3.00	0.50	6 to 1

TABLE 2 NICKEL-CHROMIUM STEEL

Carbon, 0.40 per cent, nickel, 1.0 per cent, chromium, 1.0 per cent

Part	Requirements			Heat Treatment (All parts normalized before machining)
	Ultimate Strength, lb. per sq. in.	Yield ratio, minimum	Elongation in 2 in., per ct	
Connecting Rods	145,600 to 156,800	0.75	18 to 15	[1]1550 deg. fahr.—oil [2]950-1000 deg. fahr. —oil
Valve Lifters	190,000 to 202,000	0.75	14 to 12	1525 deg. fahr.—oil 780 deg. fahr.—oil
Cams	247,000 to 268,000	Not specified	12 to 10	1525 deg. fahr.—oil—Tempered 30 min. in oil at 380 deg. fahr.

[1] Quenched in oil from 1550 deg. fahr. [2] Tempered at 950 to 1000 deg. fahr. and quenched in oil.

TABLE 3 HEAT-TREATED NICKEL-CHROMIUM STEEL

Composition (per cent). C, 0.420; Mn, 0.400; Si, 0.170; P, 0.024; S, 0.031; N, 1.120; Cr, 1.00. Size: Approx. 0.4 in. diam.

Ultimate Strength, lb. per sq. in.	Elongation in 2 in., per cent	Reduction of Area, per cent	Brinell No.
261,500	11.5	44.2	555
256,100	11.5	46.7	495
259,000	11.5	47.8	555
260,800	11.5	47.1	512
263,700	12.5	47.1	512
261,700	11.0	41.2	512
263,200	12.0	47.1	555
259,000	10.0	46.7	512
267,700	11.5	43.5	512
For 9 tests			
267,700 (max.)	12.5	47.8	555
256,100 (min.)	10.0	41.2	495
261,430 (avg.)	11.4	45.7	524

While both cams and valve lifters were of small size, the use of this steel for the former is not recommended, for it is exceedingly difficult to meet the severe requirements of the specifications. However, several thousand cams made of this steel were successfully treated and, according to all available information, proved entirely satisfactory in service, but the desired properties and uniformity as shown in Table 3 were obtained only under most closely controlled conditions. The steel used was produced in the electric furnace, and the parts were small, enabling treatments to be carried out in small electric heating units. Attention is called to this because there is without doubt a great deal of high-alloy-content steel used where cheaper and lower alloys would equally well serve the purpose, though under conditions

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[1] Met.E.; Metallurgical Division, Bureau of Standards, Washington, D. C.

Presented at a meeting of the Washington Section of The American Society of Mechanical Engineers, March 31, 1920. Published by permission of the Director, Bureau of Standards.

not as severe as those cited, thereby saving considerable expense to the industry.

The tensile properties and hardness of this steel in small sizes under varying but single heat treatments are shown in Fig. 1. Variation in tempering temperatures between about 650 and 1350 deg. fahr. gives a variation in properties approximately as follows:

Yield point, lb. per sq. in.	200,000	to	85,000
Tensile strength, lb. per sq. in.	220,000	to	117,000
Elongation in 2 in., per cent	11.5	to	25.5
Reduction of area, per cent	45	to	72
Brinell hardness	440	to	220
Shore hardness	60	to	32

3 Per Cent Nickel and 1 Per Cent Chromium Steel

Steel containing about 3 per cent nickel and 1 per cent chromium, or often somewhat lower percentages of this element, is used for crankshafts, connecting rods, etc., when higher combinations of strength and ductility are required than may be developed in the steel previously discussed. The tensile properties and hardness of such steel containing about 0.25 per cent carbon when subjected to various single heat treatments, are shown in Fig. 2. The approximate variation in properties obtained by varying the tempering temperature between about 450 and 1300 deg. fahr. follows:

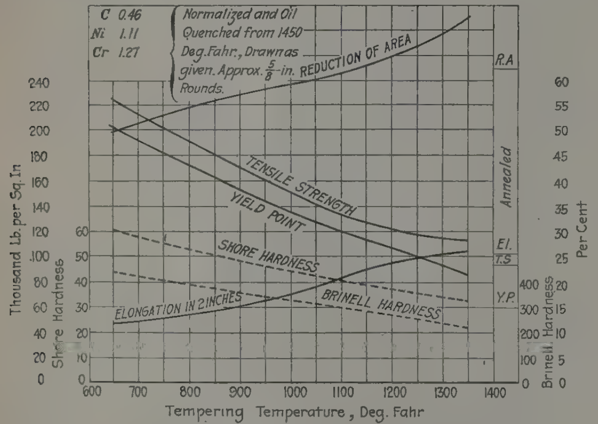

Fig. 1 Tensile Properties and Hardness Numbers of a Heat-Treated 1:1 Nickel-Chromium Steel

Yield point, lb. per sq. in.	190,000	to	87,000
Tensile strength, lb. per sq. in.	220,000	to	117,000
Elongation in 2 in., per cent	14	to	26
Reduction of area, per cent	55	to	70
Brinell hardness	440	to	240

If comparison of these values with those given for the 1-to-1 nickel-chromium steel is made it must be remembered that the higher-alloy steel contains much less carbon.

Crankshafts

The question of crankshafts for which this steel as well as others are used is one of such importance, especially for airplane engines, that discussion from the standpoint of the part itself now appears justified.

Despite the variety of design in both engines and parts, crankshaft specifications for most types of airplane engines may be grouped into two classes, as shown in detail in Table 4. There are exceptions to the values as given, but the table generally applies. Ordinarily the crankshaft requires skilled metallurgical control in all stages of manufacture and the best steels and treatments are none too good. The treatments used to develop the required physical characteristics vary, but with the steels ordinarily used a relatively high temperature—tempering above 1000 deg. fahr. is necessary, which is of course desirable. Both water and oil quenching are used, as shown in Table 5, which also shows analyses, treatments and properties obtained on several types of crankshafts. Where water quenching is used the shafts are usually removed from the bath after a given length of time and before they are cold, and immediately tempered to avoid cracking.

It is essential that the crankshafts be thoroughly annealed after forging and before machining in order to minimize distortion which sometimes occurs during the machining operations. Cold setting after heat treatment also gives trouble and in such cases the crankshafts should be rough-machined before heat treatment. Hair-line seams or streaks and "blue brittleness" are two additional factors which, while they are often encountered in production of crankshafts, are general and will be briefly discussed later.

In order to avoid such difficulties, care in melting, working, and thermal treatments is required. Acid open-hearth or cold-melt electric is undoubtedly the best steel to use. Excessive aluminum additions should be avoided and casting temperatures should preferably be under pyrometric control. Sufficient discard should be made to remove segregation and pipe, the amount depending upon casting practice, and all ingots and blooms should be carefully surfaced. The steel should be worked sufficiently so as to remove all traces of cast structure and heating whether for forging or heat treatment should be slow and uniform.

Heat-Treated, Cold-Drawn Nickel-Chromium Steel

Nickel-chromium steels have also found application in their heat-treated, cold-drawn condition where close adherence to size as well as high physical characteristics are required. Such steel is particularly useful in production of parts carrying threads where oxidation from heating after machining is objectionable. Ordinarily the bars are hot-rolled to a size close to that desired and then either normalized or quenched and tempered after which they are cold-drawn. Table 6 illustrates such drawing practice and shows the effect of cold work on the tensile properties. Increase in elastic limit and tensile strength with decrease in ductility as measured by elongation and reduction in area results. Heavy final cold reductions induce brittleness and should be avoided, and in addition impair machining qualities.

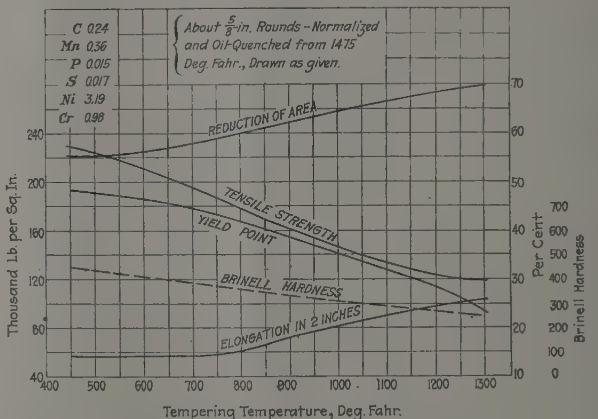

Fig. 2 Tensile Properties and Hardness Numbers of a Heat-Treated 3:1 Nickel-Chromium Steel

Gears

Nickel-chromium steels of various analyses are also widely used for gears. The type of steel recommended depends largely upon the service desired and this, of course, together with the analysis chosen influences the treatment. The steels used, however, may be divided into two groups, viz: (*a*) tempering steels and (*b*) case-hardening steels. Typical analyses of these two classes are shown in Table 7.

TABLE 4 CRANKSHAFT FORGINGS FOR AIRCRAFT ENGINES

Percentage Composition					Physical Properties				
C	Ni	Cr	P	S	Ultimate Strength, lb. per sq. in.	Yield Ratio, Minimum	Per Cent Elong. in 2 in., Min.	Per Cent Red. of Area, Min.	Min. Impact Values–Izod 120 ft-lb. machine
Stationary Engines									
Max. 0.36	Max. 4.00	0.50 to 1.30	Max. 0.045	Max. 0.05	[1]132,000 to 157,000	0.75	17	44	35
Rotary Engines									
Max. 0.35	Suitable proportions		Max. 0.045	Max. 0.05	106,000 to 128,000	0.75	17	50	40

[1] For each 4500 lb. increase above the minimum ultimate the required Izod minimum is reduced 1 ft-lb.

TABLE 5 CRANKSHAFT STEELS AND TREATMENTS

Engine	Specifications	Yield Point, lb. per sq. in.	Tensile Str., lb. per sq. in.	Per Cent Elong. in 2 in.	Per Cent Red. Area	Brinell Number	Impact, ft-lb.
A	Carbon..0.35 per cent Manganese...0.61 per cent Nickel..3.09 per cent Chromium.0.50 percent Normalized.1600 deg. fahr. 1550 deg. fahr. oil 1030 deg. fahr. oil	131,250 139,400	137,350 147,400	20.0 17.5	59.0 56.3	286 302	
B	Carbon..0.48 per cent Manganese...0.69 per cent Nickel..1.74 per cent Chromium.0.85 percent Normalized.1450 deg. fahr. Drawn.925-1125 deg. fahr.	127,700 124,500 130,350	143,150 141,000 145,700	20.0 20.5 18.5	58.8 56.4 57.2	302 302 302	Izod 120 ft-lb. machine 47 46 46
C	Carbon.0.35-0.45 per cent Manganese.0.50 - 0.80 per cent Nickel..1.00 - 1.50 per cent Chromium..0.45 – 0.75 per cent.	107,500 117,600	125,500 132,200	22.0 22.0	61.6 58.7	286 286	Olsen machine 99 99

TABLE 6 HEAT-TREATED, COLD-DRAWN NICKEL-CHROMIUM STEEL

Composition (per cent) ; C, 0.37 ; Mn, 0.68 ; Ni, 1.60 ; Cr, 0.59 ; P, 0.010 ; S, 0.034.

Size, in.	Treatment	Elastic Limit, lb. per sq. in.	Ultimate Strength, lb. per sq. in.	Elongation in 2 in., per cent	Reduction of Area, per cent
1-11/32	1540 deg. fahr. oil, Tempered 930 deg. fahr.	87,650	109,400	23.2	65.7
1-5/16	Cold - drawn 1/32 in.	108,300	140,800	19.0	57.1
1-11/32	1540 deg. fahr. oil, Tempered 930 deg. fahr.	86,200	104,800	24.5	66.1
1–5/16	Cold - drawn 1/32 in.	108,200	125,900	20.0	61.3

TABLE 7 PERCENTAGE ANALYSES OF NICKEL-CHROIMUM GEAR STEELS

	C	Mn	Ni	Cr
Tempering Steels	0.50	0.45	1.75	1.00
	0.50	0.60	3.00	0.75
	0.40	0.45	3.50	1.25
	0.30	0.45	4.50	1.50
Case-Hardening Steels	0.15	0.45	1.25	0.60
	0.15	0.45	1.75	1.00

The treatment of the first class, comprised of tempering steels, is similar to treatments previously outlined and consists in normalizing or annealing the blanks before machining, after which the gears are quenched and then tempered at comparatively low temperatures (about 500 deg. fahr.). High hardness and strength together with fair ductility can be obtained.

The second class mentioned, comprised of low-carbon case-hardening steels, requires different treatment. The machined gears are carburized in suitable carburizing material and then usually double-quenched for refinement of core and of case. The result is a material of dual nature. The core, low in carbon, has high ductility and relatively low strength, while the case, high in carbon, is extremely hard and has little ductility.

Where the highest combination of strength and ductility is not essential the gears may be carburized at somewhat lower temperatures but above the critical ranges of the steel under treatment, and then quenched but once for hardening the case. With such treatment the coarse structure of the core produced during carburization still remains but a hard wearing surface is obtained.

In general tempering steels are applicable to clash gears while the higher hardness obtained in the case of the case-hardening steels makes them admirably suited for constant-mesh gears. Both types are used interchangeably, however.

Hair-Line Seams

Two phenomena encountered in the use of nickel-chromium steels which warrant discussion are "hair-line seams," also called manganese sulphide streaks, slag inclusions, etc.; and "blue brittleness," referred to as "Krupp Krankheit" and more properly termed "temper brittleness."

The first is in many instances undoubtedly due to inclusions in the ingot and consists of manganese sulphides or silicates. Probably iron silicate and iron and possibly nickel sulphides are also present. These streaks or cracks, which are not to be confused with quenching cracks, vary in depth, length and in numbers, but are most frequently present at the surface of the finished forgings. Often removing some surface metal will cause them to disappear, only to be replaced by others, whereas sometimes the removal of a small surface layer will cause them to disappear entirely. This suggests that in some cases they may originate by being driven in from the outer surface during forging. It is therefore good practice to leave more than the ordinary amount of metal for finish-machining. However, their absence from the finish-machined forging is no proof that they do not exist in the interior. Whether such streaks are deleterious is open to discussion, but in the writer's opinion they should certainly be regarded with suspicion when present in considerable numbers, particularly if at or near sharp corners in machined forgings subjected to high stresses.

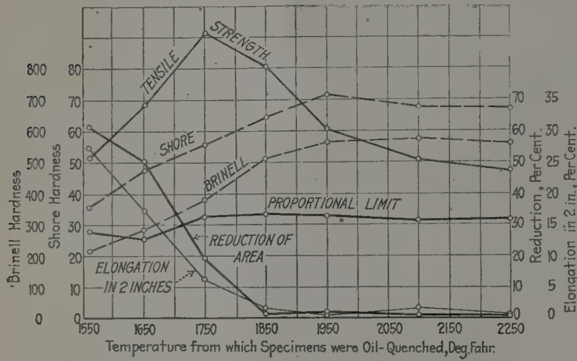

FIG. 3 EFFECT OF VARYING QUENCHING TEMPERATURE ON THE PHYSICAL PROPERTIES OF A HIGH-CHROMIUM STEEL

TEMPER BRITTLENESS

The second phenomenon mentioned is evidenced in the low impact values obtained in slow cooling from the tempering heat, between temperatures of 400 to 1100 deg. fahr., and more particularly 700 to 1000 deg. fahr. By quenching from these tempering temperatures, normal impact values are obtained. Table 8 illustrates this effect.

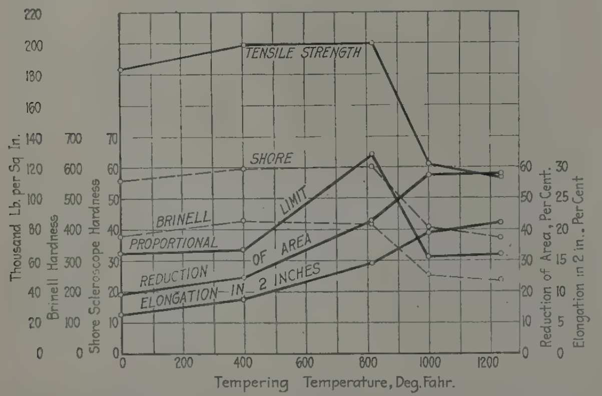

FIG. 4 EFFECT OF VARYING TEMPERING TEMPERATURE ON THE PHYSICAL PROPERTIES OF A HIGH-CHROMIUM STEEL, OIL-QUENCHED FROM 1750 DEG. FAHR.

So far, no relation between low impact values and resistance to fatigue or other ordinary tests has been found, but until proved otherwise heats showing temper brittleness should be specially treated or discarded. At least they should be questioned seriously when intended for important parts. This whole subject is now under investigation by a committee[1] appointed by the National Research Council.

TABLE 8 TEMPER BRITTLENESS OF CRANKSHAFT STEEL

Composition (per cent): C, 0.41; Mn, 0.50; Ni, 3.13; Cr, 0.82

Treatments:
1 Normalizing.......1670 deg. fahr.—air-cooled
2 Hardening........1510 deg. fahr. for 1 hour—oil quenched
3 Tempering........Heated 30 min. at 1100-1125 deg. fahr. and cooled as follows:
  (a) oil..........50 ft-lb. energy absorbed
  (b) water.........48 ft-lb. energy absorbed
  (c) still air........43 ft-lb. energy absorbed
  (d) furnace (rate from 1050-775 deg. fahr. averages 2 deg. per min.) 8.7 ft-lb. energy absorbed

CARBON-CHROMIUM STEELS—STAINLESS STEEL

Steels without nickel containing various percentages of chromium also find interesting applications in the automotive industry. For many years the use of chromium was restricted to high-carbon steels on account of difficulties in producing carbon-free ferrochrome. With improvements in production of ferroalloys some interesting steels have come into use.

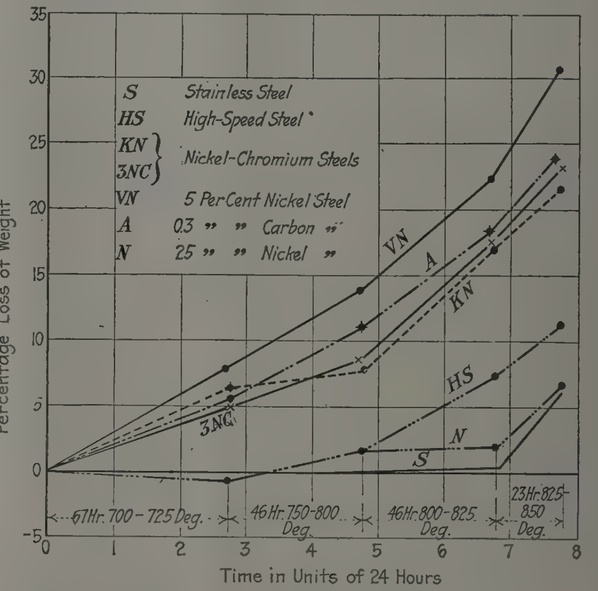

FIG. 5 RESISTANCE TO OXIDATION OF VARIOUS STEELS

One of these is steel containing about 0.20 to 0.40 per cent carbon and 11 to 15 per cent chromium, produced under the name "stainless steel." Originally used for cutlery it has found successful application in valves for airplane and automobile engines where resistance to the action of hot gases and good strength and ductility are required. Figs. 3 and 4 show the effect of varying quenching and tempering temperatures on the tensile properties and hardness, while in Fig. 5 is shown the resistance to oxidation compared with common types of alloy and carbon steels.[1] The steel presents its maximum resistance to corrosion and oxidation only when properly hardened and finished (polished or ground). It is air-hardening in small sizes and may be quenched in oil, air, or water. Quenching is best carried out from about 1650 to 1750 deg. fahr. and for valves the steel is usually tempered at relatively high temperatures—about 1250 deg. fahr. Properties obtained after such treatment are shown in Fig. 4.

CAST HIGH-SPEED STEEL CUTTERS

Before closing this discussion it will probably be of interest to touch upon another phase of the application of alloy steels in the automotive industry, namely, as cutting media. The follow-

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[1] Committee on Physical Changes in Iron and Steel below the Thermal Critical Range, Dr. Z. Jeffries, Chairman.

[1] From tentative report of Iron and Steel Committee of the Society of Automotive Engineers, appearing in Jl. S. A. E., vol. 5, no. 3, Sept. 1919, pp. 262-263.

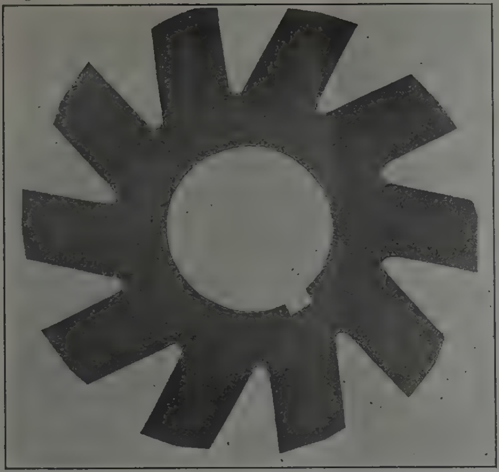

Fig. 6 Cast High-Speed Steel Milling Cutter Used in Test; Diameter, 3.75 in.

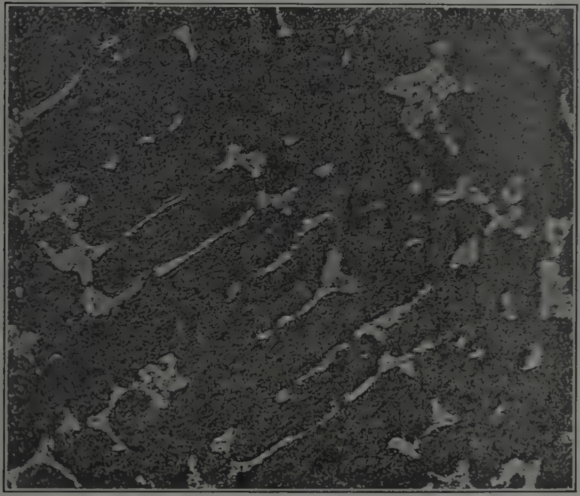

Fig. 7 Structure of Steel Used in Cutter of Fig. 6 as Cast, Magnification, 500 Diameters

ing will be confined, however, to the results of tests made on some cast high-speed steel milling cutters, which in the past have generally been made from bars or forgings. This latter method when properly carried out has the advantage of decreasing machine work as well as of saving costly material, and produces cutters of equally high if not better efficiency than those machined from bars.

Fig. 6 shows one of the cast high-speed steel cutters used in the test about to be described and having the following analysis:

Carbon	0.85 per cent
Tungsten	19.40 per cent
Chromium	4.20 per cent
Vanadium	0.86 per cent
Manganese	0.05 per cent
Iron	74.60 per cent
Total	99.96 per cent

It will be noted that both carbon and tungsten are somewhat higher than proportions usually present in high-speed steel tools produced in the usual manner, and examination of the photograph shows a remarkably smooth surface, generally free from imperfections. The structure of this steel as cast is illustrated in Fig. 7, which shows the characteristic tree-like crystals of carbide, known as dendrites, imbedded in a matrix of softer material.

One cutter having a double set of teeth joined by a curved cutting edge was tried on rail steel at two different cutter speeds and depths of cut. One set of teeth burned immediately at a speed of 100 ft. per min. and 0.200 in. depth of cut, while the second set of teeth were worn so as to be useless after cutting 2 in. at a cutter speed of 45 ft. per min. and 0.100 in. depth of cut. Examination of the structure in Fig. 8 reveals the cause of this poor service. The treatment given has not brought the coarse carbide dendrites into solution, the cast structure persisting. Comparison with the structure of a properly hardened forged tool in Fig. 9 will make this clear.

Another cast cutter was annealed at 1650 deg. fahr. for one hour and cooled in the furnace, but did not machine well and was reheated at this temperature for five hours more and cooled in the furnace. After machining to standard milling-cutter shape it was heated to 1250 deg. fahr. in 3¼ hr., then raised to 2150 deg. fahr. in 10 min., and oil-quenched. After grinding it was subjected to test in comparison with a high-speed steel cutter of standard make, the results being given in Table 9.[1]

(*Continued on page 547*)

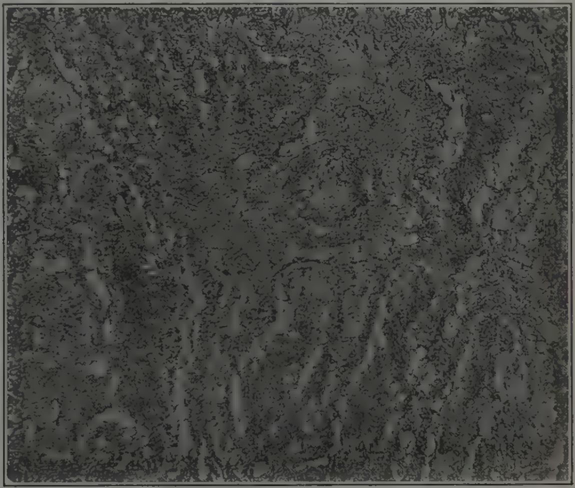

Fig. 8 Cast High-Speed Steel—Heat-Treated. Magnification, 500 Diameters

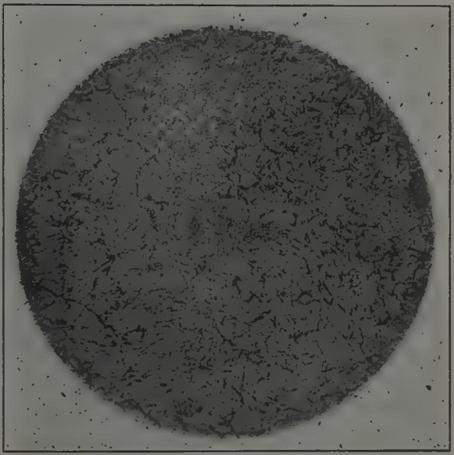

Fig. 9 Forged High-Speed Steel—Heat-Treated. Magnification, 500 Diameters

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[1] Cutting test made by M. A. Grossman, formerly of the Bureau staff. Micrographs prepared in metallographic section of the Bureau.

Some Commercial Heat Treatments for Alloy Steels

By A. H. MILLER,[1] PHILADELPHIA, PA.

The object of alloy-steel heat treatment, and indeed with a very few exceptions all heat treatment, is to produce a grain size as small as possible, with a degree of hardness suitable for the purpose intended. The three variables which must be controlled for a successful heat treatment are temperature, time, and rate of cooling, and together with these the influence of mass must not be neglected. The author of this paper deals with the heat treatment of alloy-steels used for structural purposes, especially of nickel and nickel-chrome steel. He describes a series of tests which were conducted to determine the effect of the various heat treatments on samples of the same chemical composition, and the varied results are illustrated by a series of photomicrographs which show the effect of different adjustments of the above-mentioned variables.

Alloy steels, both for tool and structural purposes, have had an increasing application for a number of years. This paper is confined to a discussion of steels for structural purposes, and will further limit itself to their heat treatment. It will apply directly to the two alloy steels which are probably used to a greater extent than all others combined; namely, nickel and nickel-chrome steels. It is to be borne in mind, however, that the statements to be made in regard to these two alloys are almost equally applicable to all of the structural alloy steels, provided temperature changes are made which correspond to the changes in the critical temperature of other alloys.

In speaking of heat treatments, a fundamental thought must always be kept in mind: All fabricated steels are submitted to a heat treatment. The differences between steels known as heat-treated and others commonly spoken of as untreated is merely that the treated steels have supposedly received a preconceived, carefully-carried-out treatment, whereas the so-called untreated steels have received a variable and generally unknown treatment which is the result of casting, forging, and cooling at an unknown and variable rate from the casting or forging temperature.

The Time Element in Heat Treatment

In the heat treatment of alloy steels the three variables which must be controlled for a successful heat treatment are temperature, time, and rate of cooling. The influence of mass on these three variables must never be neglected; moreover, it must be borne in mind that an increase in mass may increase the treatment temperature, should increase the length of time held at temperature, and will inevitably alter the rate of cooling.

Too little attention is generally paid to the time element of the heat treatment, whereas it actually is of very great importance. The illustrations, Figs. 1-7, are a series of photomicrographs of a nickel-chrome steel of the following composition: carbon, 0.35-0.40 per cent; nickel, 3 per cent; and chromium, 0.75 per cent; and show the microstructure in a typical forged condition, and after annealing at a proper annealing heat for varying periods of time. It will be noted that this series gives the time held at the annealing temperature from zero (meaning that the piece was brought to temperature and the furnace was immediately shut down) to 10 hr. A study of the photomicrographs shows that the ferrite as contained in the cell outlines of the forged specimen was not dissolved and uniformly diffused until the piece had been held at the annealed temperature for ½ hr. Fig. 7 shows that there had been a slight growth of the austenite crystals between the time of completed uniform solution at ½ hr. and the end of the run, 10 hr.

This series also shows that a new cell system may grow in steel simultaneously with the breaking up of the previously existent system. The pieces, representative micrographs of which are shown, were all cut from the same bar, and were treated by placing them together in a furnace controlled by a thermocouple, withdrawing them one by one at the end of the specified time and plunging each immediately into a box of well-aerated lime.

The reason that a considerable length of time is required to produce a uniform structure is probably as follows: After the steel is raised to a temperature above the critical temperature, the iron is in the gamma form, in which iron carbide is soluble. There is, however, a certain length of time required for this solution, and, more than that, a certain added length of time is necessary to allow the solution to become homogeneous, just as, in dissolving a lump of sugar in water, a certain length of time is required to complete the solution, and a certain further length of time for the water to become uniformly sweet. Analogously, if the iron carbide be dissolved in the gamma iron and this solution does not have time to become homogeneous before it be recooled, the ferrite will naturally separate out on cooling at the point where the greatest concentration existed in the solution.

Procedure in Alloy-Steel Heat Treatment

The object of alloy-steel heat treament, and indeed, with a very few exceptions, all heat treatment, is to produce a grain size as small as possible, with a degree of hardness suitable for the purposes intended, by the simplest possible means. Thus the ill-controlled and generally very poorly forged structure must first be broken up and a fine uniform structure established. In steels which are sensitive to heat treatment, of which the nickel and nickel-chrome steels are excellent examples, this object is best achieved in several steps, each of which is designed to break up the structure resulting from the previous step and bring the material into a more nearly ideal condition.

If the forging conditions are bad, as is the case in most forging processes, especially that of drop forging, a treatment of numerous steps may be necessary. As an example of the most drastic the following is given:

1 Anneal from approximately 1450 deg. fahr.
2 Quench from 1600 deg. fahr.
3 Quench from 1400 deg. fahr.
4 Draw at 1250 deg fahr.
5 Quench from 1400 deg. fahr.
6 Draw at such a temperature as will give the desired hardness.

This heat treatment is not of unheard length, as it is quite conceivably necessary in many cases. As a matter of fact, in manufacturing pieces which will not subsequently be forged by the purchaser, steel companies very frequently give all of the preliminary steps of this treatment to their regular product. It must be well understood, however, that this number of steps is necessary only to guard against lack of uniformity, due to one piece out of a great number having possibly been subject to a poor forging heat. If the forging temperature can be accurately regulated, however, many of the steps in this treatment can be eliminated.

In much commercial work, with good forging practice, a simple anneal at 1450 deg. fahr., followed by a quench just above the critical temperature and a draw, will put the steel in excellent preliminary condition, at which point the steel can be machined to its final shape. If conditions are such that the steel must be extraordinarily hard (as, for instance, in automobile gears), a final quench with a draw at about 400 to 600 deg. fahr. is then given.

It must be borne in mind when laying out treatments that the time at which the steel is held at temperature during any treatment, whether it be an anneal or a quench, is of quite as great

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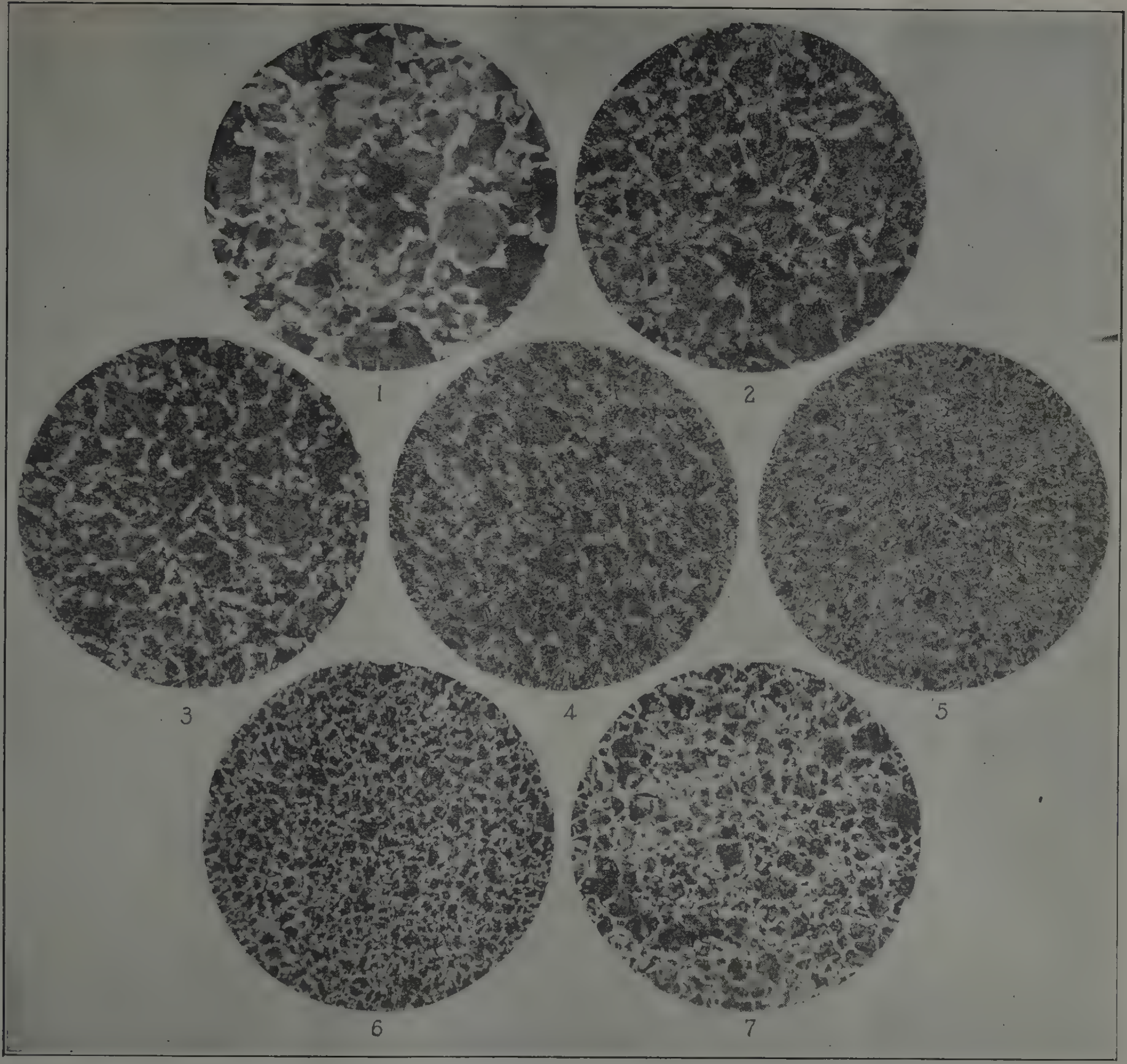
[1] Research Department, Midvale Steel and Ordnance Co.

Presented at a meeting of the Washington Section of The American Society of Mechanical Engineers, March 31, 1920.



Figs. 1 to 7 Effect of Time at Normalizing Heat (1450 Deg. Fahr.) Followed by Slow Cooling
Fig. 1 As forged. Fig. 2 Not held, cooled in lime. Fig. 3 Held 5 min. Fig. 4 Held 10 min. Fig. 5 Held 15 min. Fig. 6 Held 30 min. Fig. 7 Held 10 hr. x 80.

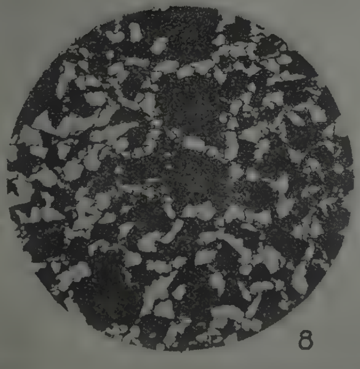


Fig. 8
Heated to 1,400 deg. fahr.
Not held, quenched in oil.
Reheated to 1,150 deg. fahr
Held 30 min.
Cooled slowly. x 100.

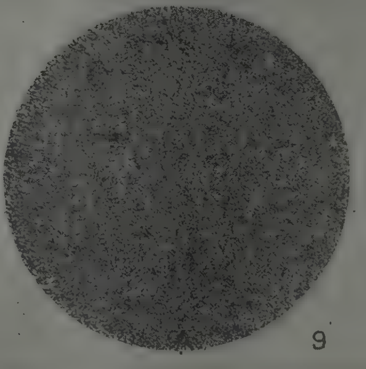


Fig. 9
Heated to 1,400 deg. fahr.
Held 30 min.
Quenched in oil. x 100.

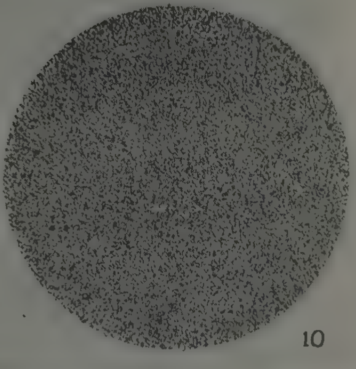


Fig. 10
Heated to 1,450 deg. fahr. for 30 min., cooled slowly.
Heated to 1,600 deg. fahr. for 30 min., cooled slowly.
Heated to 1,400 deg. fahr. for 30 min., cooled slowly
Heated to 1,150 deg. fahr. for 30 min., cooled slowly.
x100.

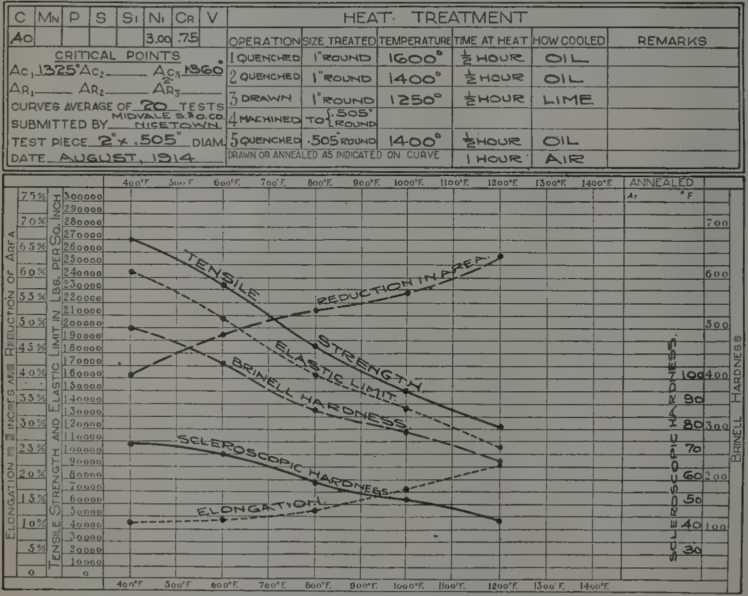
importance as the temperature. This is illustrated by photomicrographs, Figs. 8-10, of two pieces cut from the same bar as those previously shown, both of which were placed in the furnace together. One of these pieces was drawn from the furnace and quenched immediately it had reached the quenching temperature (in this case 1400 deg. fahr.). The other was allowed to remain in the furnace for ½ hr. and was then quenched. It will be seen that the ferrite areas in the first case had been slightly or incompletely broken up, whereas in the second case they were very completely dissolved.

These photomicrographs differ from a corresponding one in the first series of annealed samples in that there is shown no new grain growth within the old partially broken-up system. This, of course, is due to the fact that in the second case the time element necessary for the separation of the ferrite during cooling was not sufficient.

Results Obtainable in Heat-Treating Alloy Steels

From results obtained in the careful heat treatment of nickel-chrome steels, a series of curves, Fig. 11, has been prepared which show the physical properties of a nickel-chrome steel resulting from proper preliminary treatment and varying drawing temperatures.

The type composition only is given in this figure, because it is a mean of the results of about twenty bars from several heats of slightly varying compositions. The nickel steels of the same approximate carbon content give results which are somewhat inferior to this nickel-chrome curve, whereas the results of another type of nickel-chrome steel, of 3½ per cent nickel and 1½ per cent chromium, would be slightly superior.



C	MN	P	S	SI	NI	CR	V
A0					3.00	.75	

CRITICAL POINTS
AC₁ 1325° AC₂ ____ AC₃ 1360°
AR₁ ____ AR₂ ____ AR₃ ____
CURVES AVERAGE OF 20 TESTS
SUBMITTED BY MIDVALE S. & O. CO. NICETOWN
TEST PIECE 2" × .505" DIAM.
DATE AUGUST, 1914

HEAT TREATMENT

OPERATION	SIZE TREATED	TEMPERATURE	TIME AT HEAT	HOW COOLED	REMARKS
1 QUENCHED	1" ROUND	1600°	½ HOUR	OIL	
2 QUENCHED	1" ROUND	1400°	½ HOUR	OIL	
3 DRAWN	1" ROUND	1250°	½ HOUR	LIME	
4 MACHINED	TO .505" ROUND				
5 QUENCHED	.505" ROUND	1400°	½ HOUR	OIL	
DRAWN OR ANNEALED AS INDICATED ON CURVE			1 HOUR	AIR	

Fig. 11 Physical Properties of a Nickel-Chromium Steel Resulting from Proper Preliminary Treatment and Varying Drawing Temperatures

Starting from the extended heat treatment just described, the development of the cheapest and simplest treatment which will give good results is a matter of intelligently eliminating or altering steps of the ideal heat treatment as conditions permit. For instance, in a certain case where important drop forgings were manufactured from the grade of nickel-chrome steel shown on the curve, the actual treatment to which pieces were subjected is as follows: The pieces were forged under a drop hammer, and were dipped immediately afterward into a tank of oil which was maintained close to the forge. The pieces were kept in this oil for about four minutes, removed at a temperature between 700 to 900 deg. fahr., and were buried in ashes as a precaution against cracking. Then the pieces were subjected to a single quench at 1400 deg. fahr. and were drawn at 1200 deg. fahr., in which condition they were machined and received no further treatment. The uniformly excellent results obtained (each of the pieces was separately tested) showed that this very simple treatment had been entirely effective. A little thought will show that the reason for this was that the drop forging was not excessively high, and that the growth of large-cell outline was prevented by the quench after forging was completed. The single quench and draw were sufficient to completely refine the steel from the fair condition which was thus produced.

There is this to be observed in all cases of quenching of alloy or indeed any other steels: Following the quench, the piece quenched is in a condition of great strain and is liable to crack. This liability to crack persists until the piece has been drawn, and it is therefore wise to draw the piece as soon as possible after the quenching.

In cases where a drastic quench is advisable it is better to remove the piece from the quenching medium before it becomes entirely cold. By this procedure the great proportion of the condemnations due to cracking are avoided.

Fiber Fracture a Criterion of Proper Treatment

One of the significant effects of a correct heat treatment on alloy steels, which is indeed a criterion as to the efficiency of the treatment, is the production of a peculiar type of fracture in a broken piece, known as "fiber." This fiber fracture is absolutely distinctive, and cannot be mistaken by one who is even slightly skilled in inspection. It is produced in all of the well-melted, shock-resisting alloy steels by proper heat treatments, and is so closely related to impact test values that failing impact tests can almost invariably be selected from broken impact test bars by the absence of this type of fracture. The ease of producing fiber by heat treatment is a criterion of the value of an alloy for shock-resisting properties. So important is the presence of this feature that armor plate, which must withstand shock test of the more severe character, is never knowingly shipped without it.

In its report covering its activities for the year 1919, The National Physical Laboratory (England) reviews its accomplishments in many fields of science, among them being its work in metallurgy. The most important work in the Metallurgy Department of the laboratory was in connection with the production of light alloys, especially for aircraft and aeroplane engines. Alloys were developed to meet special requirements for castings in general, and for parts such as pistons working at high temperatures; wrought alloys were produced for use in the construction of rigid airships, aeroplane spars, etc.; and the rolling of light alloys into thin sheets to serve as a substitute for fabric in covering aeroplane wings was successfully accomplished. Special investigations were made with the object of providing substitutes for alloys for munitions when difficulties of supply arose. Among these was a substitute for the use of antimony in hardening lead for shrapnel bullets. Another case in which a substitute was required was the aluminum tip forming part of the standard small-arms bullet at the beginning of the war. The possibility of replacing the aluminum tips by bodies of precisely similar size, shape, and weight was thoroughly demonstrated, with the collaboration of a pottery in the Manchester district, where the difficulty of preparing small pottery bodies with the necessary accuracy of shape and dimensions was successfully overcome. Investigations were made on steel for torpedo air vessels and turbine gearing, and methods of hardening and case-hardening war material were improved.

The St. Lawrence River Project

An International Project Which Promises Unlimited Benefits in Solving the Transportation Problem of Central North America as Well as the Fuel and Power Crisis of the Eastern Seaboard

By HORACE C. GARDNER,[1] CHICAGO, ILL.

For centuries the rapids of the St. Lawrence have been regarded as a drawback to the development of the surrounding country, and in the sense that the people of a century ago comprehended the matter they are still a disadvantage. But with the existing demands for power and inland transportation systems already breaking down under the stress of traffic, the river and its rapids should be looked upon as a resource and one of nature's best gifts, for they furnish the solution to both power and transportation problems. It is to this proposition that the author of the following paper has addressed himself. If developed, the improved St. Lawrence, together with the Great Lakes, would constitute, the author states, a waterway from the heart of North America direct to the continent of Europe. And as a result an ocean steamer could be loaded at a Great Lakes port and not discharge its cargo until it reached a European port. This, of course, would relieve the congestion which now takes place on the railroads every year during the season when the crops of the West and Middle West are shipped to the seaboard. It would also materially lessen the car shortage which occurs during that period, and moreover it would lessen the expense of shipping. The problem, the author states, is not a new one. It is over a hundred years old, and during the past seventy-five years the Canadian Government has been making improvements, most of which, however, are not large enough for the present demands. At the present time the Great Lakes-St. Lawrence Tidewater Association is endeavoring to encourage coöperation between the United States and Canada in the development of the St. Lawrence both for navigation and power. The International Joint Commission, which consists of three representatives of the United States Government and three representatives of the Canadian Government, are also holding hearings at various places in both countries to learn the sentiment of the people. The paper is an interesting discussion of an important problem which is bound to receive considerable attention in the immediate future.

IN 1534 Francis I, King of France, commissioned that most famous French navigator of the time, Jacques Cartier, to attempt the discovery of the much-sought northwest passage to India. Accordingly in the spring of that year Cartier sailed from St. Malo and spent the summer in and about the St. Lawrence gulf, during which time he circumnavigated Anticosti Island. He actually entered the mouth of the St. Lawrence River, but he was not sure as to whether it was a river or an arm of the sea. In 1536 Cartier made another expedition and explored the St. Lawrence for 550 miles, or as far as the present site of the city of Montreal. The encouraging results of these expeditions brought about others, and eventually the five fresh-water inland seas that have come to be known as the Great Lakes were disclosed to the world, which, together with the St. Lawrence, constitute one of the finest, and in many respects one of the most remarkable, fresh-water basins and drainage systems on the globe.

The entire distance from the headwaters of the St. Louis River, in Minnesota, which flows into Lake Superior, to the mouth of the St. Lawrence River, is 2100 miles. The lakes themselves, constituting enormous reservoirs, cause the great river to have the most even flow of any of the earth's large streams. The variations between mean flow and maximum and minimum is but 25 per cent of the mean in contrast with thirty times the minimum at the mouth of the Ohio, and practically the same extremes in the Mississippi at Keokuk.

But the great disadvantage of the river is its rapids, the greatest of which is the Lachine, which ends at Montreal. The total fall between the outlet of Lake Ontario and mean tide at St. Lawrence is 221 ft. For centuries these rapids have been regarded as an enormous disadvantage, but with the present need for power and modern methods of development the people of both the United States and Canada are sure to reach within a decade or two a condition of thankfulness that the rapids exist.

It will perhaps be interesting to speculate as to what would have been the order of development of population and industry on the North American continent had the St. Lawrence been an ordinary stream without the great rapids and had the Great Lakes been connected to this outlet by intermediate channels with only the normal fall of the usual river. The St. Lawrence proper was explored for its full length in 1536, and it will be recalled that settlements were made on the Atlantic Coast as follows: Jamestown, Virginia, in 1607; New Amsterdam (Manhattan Island) in 1615; and Plymouth, Mass., in 1620. It would therefore seem evident that had it been possible to conduct water transportation by the vessel of that day from the Great Lakes basin directly to Europe, actual colonization would have been under way on both shores of Lake Erie and Lake Ontario while the English were establishing themselves on the Atlantic Coast and the Dutch in eastern New York. The impetus then would have been in the Great Lakes basin; and, with the superior fertility of these lands in mind, it seems probable that populous centers would have been established on the shores of the Great Lakes, with settlements and developments extending westward, and with the less fertile marginal lands along the Atlantic Coast in a much more backward state. But nature provided otherwise, and the rapids of the St. Lawrence proved so much of a barrier to commerce that it took a century for the advance of civilization to reach Detroit and another century to reach Ft. Dearborn; and it was not until recently that the people awakened to the supreme necessity of providing adequate facilities so that ocean-going ships may pass up the St. Lawrence and navigate these fresh-water seas in the heart of the continent.

The territory included within the heavy lines on the map of the United States, shown in Fig. 1, is economically nearer to the ports of the St. Lawrence and Great Lakes than to any seaport east, south or west, either in actual miles or because of mountain ranges to be crossed. This territory is correctly called the heart of our country. It embraces something more than a third of our continental area, with more than a third of the population and more than a third of the wealth. All who know the United States are aware of the fact that in this area lies potentially much more than one-third, and probably much more than one-half, our productive capacity. According to the latest figures available its present productivity may be stated as follows, in terms of percentage of the total:

Corn	65	Apples	21
Wheat	74	Beet sugar	53
Flax, practically	100	Wool	47
Cattle, beef	50	Coal mined	36
Hogs	57	Coal reserves	72
Horses	60	Copper	39
Butter	54	Lead	46
Eggs	54	Iron ore	85
Cheese	57	Zinc	74

On the map of Fig. 1 it will be noted that various centers are indicated by numbered circles. These are the centers of production of various products, comprising practically all of the fundamental necessities of life.

With one exception—the center of population—the locations are the crossings of median lines. There are two methods of determining such centers. One is to calculate and determine a point at which, if all of the given product were assembled and piled in one pile, the least possible transportation would be necessary. The center of population as shown on the map was so determined by the Census Bureau. The other method, and the one used with respect to all of the centers except population, is to determine a north and south line, east and west of which half of a given product is produced; then determine an east and west line, north and south of which half is produced. It is at the crossing of these median lines that the center is located. In determining the centers used in this paper, other than the center of population, the latter method was employed.

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[1] Gardiner and Lindberg. Mem. Am. Soc. M. E.

Abstract of a paper presented before the Chicago Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, June 8, 1920.

To theorize further on the two methods, the determination of the crossing of median lines gives quite as useful and satisfactory results as the first method, but it would not necessarily do so with respect to everything, as, for example, citrus fruits. These are grown in Southern California, to a small extent in Arizona, and in Florida. The actual center would probably lie in the eastern part of Southern California. If Florida produced approximately the same quantity as California, a north and south line bisecting the total production might lie almost anywhere between California and Florida, and would certainly come in a territory of no production. Fortunately, most of our fundamental staples are produced over large areas, and the method of determining the crossing of median lines is as accurate and satisfactory as any that can be devised. Moreover, in considering the significance of the location of such centers, the normal direction of freight movement, which is always from the region of greatest production toward the region of less or no production, must be kept in mind. Grain, foodstuffs and feed move always toward the east, while manufactured products, for the most part, move toward the west.

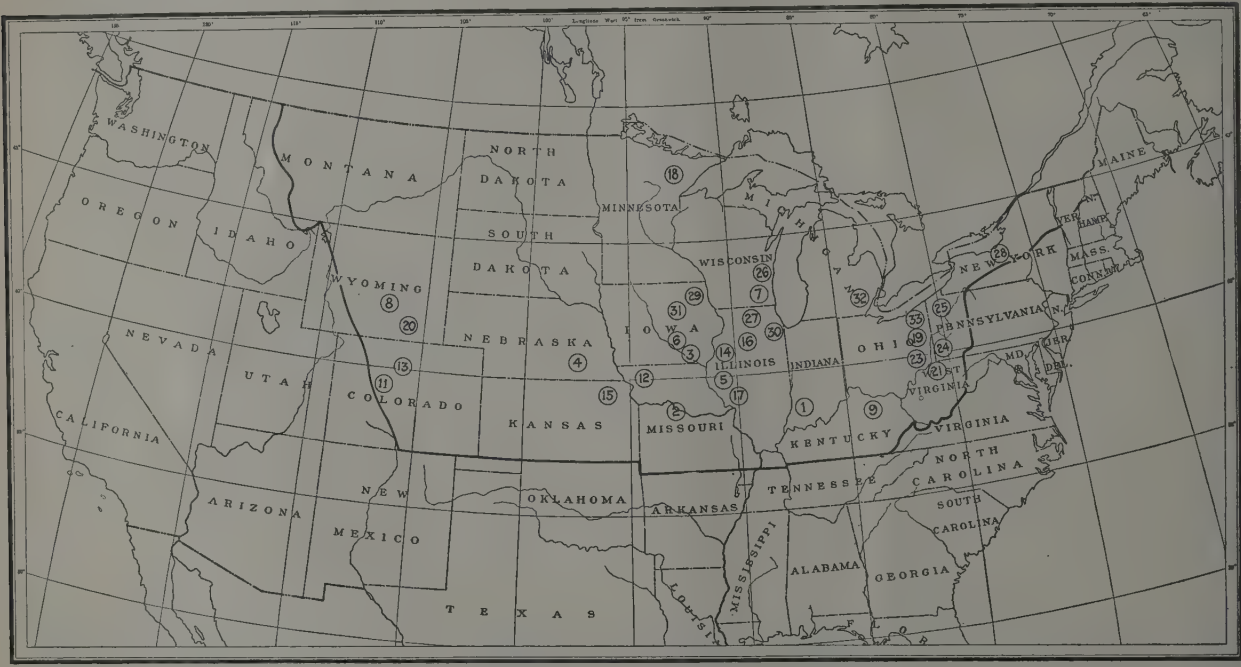


Fig. 1 Centers of Productivity in United States

The centers as shown on the map have been determined by the use of the latest figures available. The center of population was determined according to the census of 1910. Many of the most important figures are founded on figures of the Census Bureau bearing the date of 1914, but these centers do not shift rapidly.

The Present Freight Situation

And yet with all this potential and actual wealth both the United States and Canada have suffered, for business has been hampered by the lack of transportation. There are many reasons for this condition, but the fundamental one is due to the fact that such an enormous part of the total production must travel long distances by rail and the railways are congested progressively as one moves eastward. The greatest transportation demand comes every year at the crop-moving season. Taking the experience of past years, it is found that the distribution of car supply is such that some sections of the country have too many and others too few cars to handle the business. As a rule, cars are well distributed in the spring, but when the crop-moving season begins there is always an abnormal movement of the car supply toward the seaboard. At the height of this season the distribution is so abnormal that the supply of cars east of the Alleghany Mountains is about 120 per cent and in the central part of the country about 80 per cent of the normal supply. This condition prevails for several months. It occurs, of course, because of the large amount of tonnage which the railroads must carry during the fall and early winter. There is a very natural disposition upon the part of the railroad lines to hold empty cars for westbound loading, hoping that they may be relieved of the necessity of moving cars without load in great numbers and over long distances. To some extent this is justified, because the demand for merchandise always increases after the crops are moved and the farmers have the increased buying power that comes therefrom. To some extent, no doubt, the railways delay empty-car movements longer than they should to postpone this dead expense. They are particularly prone to do so when there is a shortage of motive power and of man power, also a shortage of fuel, all three of which conditions have prevailed within the past six months.

During the latter part of 1919 and up to the present time, instead of working toward a normal car distribution as might be expected during that season of the year, conditions have become increasingly worse, not only because of the three conditions just named but also on account of the shortage of vessel room for export cargoes and of local strikes among the railway switchmen and dock laborers. In fact, vessels have lain at anchor in New York Harbor for weeks waiting for a place to berth. The whole situation has become almost intolerable and in many cases shippers have been put to great and unexpected expense. Three or four cases of excessive charges on export consignments shipped through the port of New York within the past few months are as follows:

Case 1—6 barrels, weight 521 lb.:	
Freight to New York	$4.94
Cartage to warehouse	4.50
Cartage to steamer	4.50
Overtime for delay of truck	7.20
Case 2—8 crates, weight 96 lb.:	
Freight to New York	$0.96
Cartage to warehouse	6.00
Cartage to steamer	6.00
Case 3—156 packages toys:	
Freight to New York	$22.56
Freight to warehouse	78.00
Cartage to steamer	14.25

Such conditions are necessarily ruinous to export trade because shippers cannot possibly satisfy their customers, nor can they afford to take the risk of making prices that would under ordinary conditions afford them a reasonable profit. No doubt a considerable part of our high cost of living comes from exactly such conditions. At our various ports and at many other interior points our domestic shipments have been delayed as well as subjected to many unusual expenses.

What is the remedy for this intolerable state of affairs? The answer is short—better transportation. There are, however, many ramifications of the problem. First, our railways must be rehabilitated, provided with an ample number of cars and adequate motive power, and must build up their personnel to take much better care of business. Fundamentally, however, it is wrong to impose upon the railways the enormous peak load of tonnage that comes every year during the crop-moving season, requiring them either to build up their freight-carrying capacity equal to the peak and consequently to have much of their rolling stock and power idle for several months in the year, or to repeat just what is being experienced at the present time; that is, to allow empty cars to pile up in the eastern zone and suffer the consequent shortage in the Central West.

A study of figures showing our exportations of grain and heavy freight shows that if we could load vessels at the ports of the Great Lakes and sail them direct to European ports, practically all of the excessive peak load could be absorbed and incidentally a tremendous car-mileage could be avoided. For example, wheat, which constitutes the greatest tonnage item of all our exports, comes principally from the Dakotas, Minnesota and Kansas. Think of the car-mileage involved in transporting this wheat to the Atlantic seaboard that could be saved if the vessels were loaded at the convenient ports on Lake Superior, Lake Michigan, and at Detroit and Toledo. Furthermore any railway system upon which tonnage of this class originates that could deliver directly to docks without leaving its own rails, could have much better control of disposition of empty cars; they could be rushed west for reloading not only without delay but without any of the red tape and trouble incident to business that must move over two or more railway systems.

The real remedy, then, for our annual freight blockade would seem to be to open the Great Lakes so that ocean-going vessels may freely enter and make use of the various ports, at many of which our railway systems already center. This being an acknowledged fact, it is, indeed, rather puzzling to know why we have suffered for so many years so greatly without taking real steps to remedy the difficulty.

PAST IMPROVEMENTS AND PROGRESS

In applying our remedy such improvements of the St. Lawrence River and of the canal across the Niagara peninsula must be made that vessels of ocean-going type and large size can be admitted. The subject is almost a century old; in fact, in an academic way it was thought out and discussed much more than a century ago, and three-quarters of a century ago a series of canals were built around the various rapids of the St. Lawrence River and across the Niagara peninsula. These, while adequate for their time, were soon outgrown. They were improved somewhat so that vessels drawing up to 14 ft. of water might come and go. However, with the rapid increase in the size of ships these canals soon proved too small and have constantly hampered commerce. Something over twenty years ago the subject became quite active and the Canadian Government undertook surveys and estimates as to the practicability and cost of improving the Ottawa River and the building of a canal across the divide to the French River and down that stream to Georgian Bay. Even then their ideas as to size were such as would not now receive serious consideration. These surveys and estimates showed, however, that canals with the depth and lock capacity for vessels of 20 ft. draft would cost practically $100,000,000. There was at that time in Canada a considerable sentiment in favor of building a canal entirely through Canadian territory. About the same time consideration was given in this country to the idea of building a canal from Albany to Lake Ontario. Fundamentally the plan was, of course, to meet the proposed all-Canadian canal with an all-American canal. Studies and estimates were made in detail. One of the propositions considered was for a canal with a depth of 30 ft. The estimate at that time gave the cost as about $200,-000,000. Nothing was done, however, and we were soon in the midst of the Spanish-American War, following which the Panama Canal attracted the attention and energy of the country.

About two years before the European War began, Canada undertook on her own account the construction of a new Welland Canal across the Niagara peninsula; the depth through the earth sections to be 25 ft. and the miter sills of the locks 30 ft. The expected cost was $50,000,000 and the work was well under way when, in the summer of 1914, Canada found herself at war. The work was courageously continued for about one year, when for financial reasons and lack of man power it was stopped. Within a year after the armistice Canada resumed work, and it is expected this canal will be finished within three years. It will be adequate for the typical ocean freighter of today, in fact, for all of the commercial fleets of the world with the exception of a very few large ships, which are principally used on the North Atlantic.

What about the St. Lawrence Rapids? How can they be avoided or what may be done to enable vessels to come up and use the new Welland Canal? About a dozen years ago, Gen. W. H. Bixby, then Chief of Engineers of the United States Army, pointed out in an address that a full investigation would probably show that the St. Lawrence might best be improved by building a series of great dams, drowning out the rapids and converting them into lakes, putting in locks so as to pass vessels of any size desired. This suggestion, which by the way General Bixby does not claim to have originated, was of course not based upon definite surveys and full engineering consideration, but it seems to be the general opinion that, upon full study, this method will be found the best. One of its great advantages is that it would incidentally develop a large amount of power.

RECENT PROGRESS

In the very early days of 1914 a committee representing commercial and other bodies in the Central West visited Washington and took up with the Department of State the question of uniting with Canada in the making of adequate improvements in the St. Lawrence so that both countries might have the use of channels and facilities suitable for ocean-going ships; also the development of the incidental power. The Department of State officially brought up the question with the Canadian Government and it was pending when the war came on and then of course nothing was done. A little over a year ago the subject was again taken up and an organization known as Great Lakes-St. Lawrence Tidewater Association was effected, the purpose being to create in this country a sentiment in favor of uniting with Canada for the improvement of the St. Lawrence both for navigation and power. This association has working headquarters in Duluth and it became active at once. Generally, a most sympathetic feeling was experienced and Congress was appealed to and very promptly passed a joint resolution referring to the International Joint Commission the problem of (*a*) an investigation as to the need for the improvements; (*b*) the best method; (*c*) the probable cost, and (*d*) the proper and equitable division of the cost between our country and Canada.

The International Joint Commission is composed of three members from the United States and three from Canada. It is a standing Commission that has been in existence for eleven years. It was created by virtue of a treaty between the two countries, and has jurisdiction of all boundary waters and problems in connection therewith.

Immediately after our Congress passed the joint resolution the Canadian Government, by order in Council, took the same action. Following this each government appointed a conferee to consider the exact instructions to be issued and to lay down for the International Joint Commission the exact scope of the work to be done. These conferees agreed promptly on the series of problems and questions. The two governments also each appointed an engineer charged with the duty of deciding upon the engineering questions; that is, the best method for making the improvement and the probable cost. The engineer for the United States is Colonel Wootten, an army engineer stationed at Detroit. The engineer representing the Canadian Government is Mr. W. A. Bowden. These engineers are actively at work. The International Joint Commission is now engaged in a series of hearings as to the need for the improvement; they have had meetings and presentations have been made by commercial bodies and others at various points in Canada and in the states of North and South Dakota, Montana, Idaho, Wyoming, Colorado, Nebraska, Iowa, Minnesota, Wisconsin, Michigan, Ohio and New York—additional hearings to follow in October. It is hoped that the Commission will reach an agreement and file its report with the two governments next December.

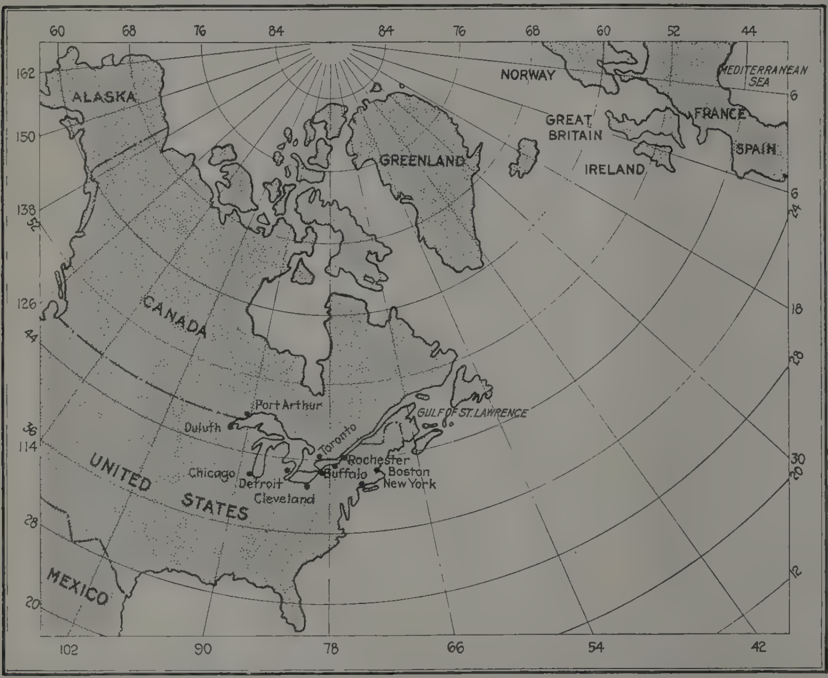


Fig. 2 Relation of Atlantic Coasts of United States and Europe

Advantages of St. Lawrence River Route

To the American mind, of course, very naturally comes the question, Why the St. Lawrence? Why not an all-American route up the Hudson and into Lake Ontario? There are, however, several very good reasons for favoring the St. Lawrence. In the first place, nature shaped the course of the St. Lawrence so that it runs from the heart of the North American continent directly toward the principal ports of Europe. This fact, however, is somewhat difficult to realize from the ordinary map. Fig. 2 shows, as well as can be shown on a flat surface, the relation of not only of the St. Lawrence River and its outlet but of the entire Atlantic coast of the United States and the Atlantic coast of Europe. The following comparisons of distance should be of interest: Rochester is nearer to Liverpool than New York; Buffalo is but a few miles farther; Toledo is nearer Glasgow, Belfast and all the Scandinavian and Baltic ports than New York; Detroit is but a few miles farther. From all our ports on Lakes Ontario and Erie it is 250 miles farther to Liverpool, London and the northern French ports and all North Sea ports via New York than via the St. Lawrence; to Glasgow, Belfast, Scandinavian and Baltic ports this differential is 500 miles. To the Mediterranean ports, however, the handicap via the St. Lawrence is but slight and not worth mentioning. It is readily seen, therefore, that distance is in favor of the St. Lawrence route.

Another reason is that there are but 45 miles of rapids, and if these be drowned out by the building of the dams, there would be a minimum of restricted channel.

Hydroelectric Resources

Another tremendous benefit to be derived is that of hydroelectric development. The normal mean flow of the St. Lawrence River at its outlet from Lake Ontario is 240,000 sec-ft. There are a number of affluents but they are all of minor consequence, except the Ottawa, which enters the St. Lawrence just above Montreal, and hence are not to be considered as amounting to much so far as the power development is concerned. There is between the head of the rapids near Ogdensburg, N. Y., and the foot of the lowest rapid just at the city of Montreal, a total fall, as before stated, of 221 ft. This is divided into several rapids, and in the river proper above Montreal there are two lakes: Lake St. Francis, about 30 miles long, and Lake St. Louis, about 16 miles. Of course these lakes would not be interfered with. Some channeling has already been done in them, but more is necessary. The levels will probably be raised somewhat by the series of dams already spoken of, and the pools that would be caused by them, together with these two lakes, as well as the whole body of Lake Ontario, would give a reservoir capacity that would be ample, so that the river flow might be almost absolutely controlled and the power production timed to meet the demand. In fact, there is now under consideration by the two governments the question of controlling not only the flow of the St. Lawrence but of the Niagara River as well, the purpose being to compensate for the diversion of water through the Chicago Drainage Channel. The Sanitary District Trustees have offered to meet the cost, which is comparatively small. This question of control of the flow of the St. Lawrence will no doubt be merged with the improvement of the river for navigation and power. Deducting from the 240,000 sec-ft., say, 10,000 sec-ft. for diversion through the Chicago Drainage Channel, and reckoning on the remaining 230,000 sec-ft. at full head, the power development on the 100 per cent basis would amount to 5,750,000 hp. If 70 per cent can be realized, the development will amount to over 4,000,000 hp. Offhand, this would seem to be practicable.

The first 113 miles of the river from its outlet from Lake Ontario are international, that is, they constitute the boundary between the two countries. The fall in this section, which is confined to about 45 miles, is 92 ft. and the power possibilities, on the same basis, would be practically 1,660,000 hp. Normally half of this would go to Canada and half to the United States.

(*Continued on page* 527)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

SUBJECTS OF THIS MONTH'S ABSTRACTS

Recent Utilization of Water Power
Efficiency of Francis Wheels
Tendencies in Design of Francis Wheels
Kaplan Hydraulic Turbine
Hydraulic Section of Report of National Electric Light Association
Combined Operation of Hydraulic and Steam Plants
Impact Tests on Alloys
Pelton-Wheel Reconstruction
Ruston and Hornsby Crude-Oil Engine
Ingersoll-Rand P-R Oil Engine
Monel Metal Working
Hack Saws
Electrically Welded Ship "Fullagar"
Cardan Shafts, Strength of
Frameless Automobile
Emmet Mercury Boiler
Waste-Heat Boilers
War Experience with Merchant Ships

Recent Utilization of Water Power

In the years 1890-1898 a power station was erected at Chevres, near Geneva. It consisted of 15 Jonval turbines of the multiple-runner type, each having an output of 1200 hp. under a maximum head of 26.5 ft. and at a speed of first 80 r.p.m. and then 120 r.p.m. In its day, which was not so long ago, this plant was representative of the highest stage of hydraulic engineering as it existed. If this plant were built today and equipped with high-capacity Francis turbines, a *single*-runner turbine at 120 r.p.m. would give an output per unit of 2500 hp., or, conversely, with an output of 1200 b.hp. the maximum speed would be approximately 175 r.p.m., which would mean a very material saving in the cost of the electrical-generator equipment. With each unit consisting of a double Francis turbine, a maximum output of 5000 b.hp. would be secured at a speed of 120 r.p.m., or with the original output of 1000 b.hp. a speed of 290 r.p.m. would be obtained.

To present the recent advances and present state of water-turbine development was the purpose of the paper recently presented before the Institute of Mechanical Engineers (Great Britain), by Eric M. Bergstrom, from which the above facts are taken.

Under the heading of Francis turbines Mr. Bergstrom calls attention to the early development of standard turbines which could be sold at an exceedingly low cost. This was followed by an increase in size of units specially designed for the conditions of installation which gave considerably greater economies than could be realized from standard machines. Following this development came the recognition of the value of "specific speed," which many leading manufacturers now use as the basis for the manufacture of standard runners, a series of runners corresponding to a certain specific speed being selected as standards to meet the conditions most frequently met with.

The important factor in connection with modern turbine practice is that exhaustive tests have been made giving a complete knowledge of the efficiency and other characteristics of each standard wheel made, so that knowledge of its behavior under varying conditions will enable a runner to be selected which will meet most efficiently a given set of requirements. The standardization of the modern turbine has been developed from these improved methods of systematic tests which provide definite knowledge of the chief characteristics of the turbine. The early American standardization practice was empirical in nature and did not encourage further developments.

It is a general practice for European turbine manufacturers to install testing plants within their own works. This enables them to accurately analyze not only standard runners, but any new special designs. The importance of tests of research work has best been shown by the evolution of the Francis runner, the development of which has been possible by exhaustive trials and intelligent applications of the results obtained.

The development of the high-capacity runner has enabled designers to use a higher value of specific speed during the last ten years. Where the limit of specific speed was approximately 75 (330 metric system) in 1909, today turbines have been installed with a specific speed of approximately 95 with good efficiencies resulting. It is now possible to obtain runners of specific speed of 100, together with even a higher maximum efficiency than secured previously with a specific speed of lower value and with only small sacrifice in efficiency at part gate.

A design of runner recently constructed by the Escher Wyss and Co. gave good results at speeds corresponding to a specific speed of from 85 to 112. The main feature of this new turbine, shown in Fig. 1, is the large space between the guide vanes and the entrance edge of the runner.

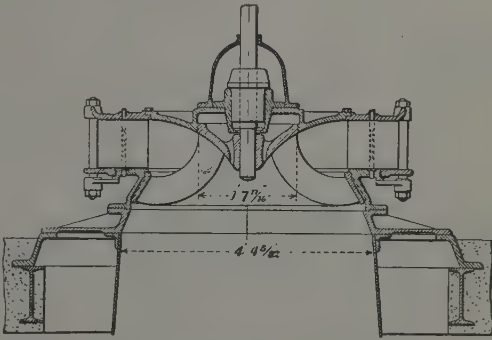


FIG. 1 New Type of Turbine, Built by Escher Wyss & Co.

Two examples of notably high efficiencies are given: the American installation at the Appalachian Power Co. with a 6000-hp. single open vertical unit operating under a 49-ft. head at 116 r.p.m., specific speed 69.5, with an overall efficiency of 93.7 per cent; the Forsse Hydroelectric Plant, Sweden, with a 3750-hp., double enclosed horizontal unit, operating under a 57-ft. head at 250 r.p.m., specific speed 80, giving a maximum overall efficiency of 94 per cent. Other efficiencies ranging from 87 per cent up are given of plants installed in Norway, Switzerland, Canada, and the United States.

It follows logically that these most notable achievements in maximum efficiencies are the results of the more careful and correct runner design referred to before. Improvements in the design of casing, guide apparatus, suction casings and suction tube are based on a better understanding of the conditions of flow in various parts of the turbine, thus eliminating as far as possible impact losses and eddy losses in the water during its passage through the turbine.

Another significant fact is the long range of gate openings for which an efficiency of over 80 per cent is obtained. In 1911 results of experiments were published showing the average efficiency of tests then on record to be 85 per cent. This value has been greatly exceeded, and a general increase of 10 per cent above efficiencies obtained twelve years ago can now be recorded.

The low-pressure Francis turbines used for heads up to 75 ft. are in Europe generally located in open flumes to which the water is conducted through an intake channel, the plant being arranged with vertical or horizontal shaft. The American arrangement for this class of turbine is generally a single vertical turbine, and the most notable developments in hydroelectric plants have been with this type of runner.

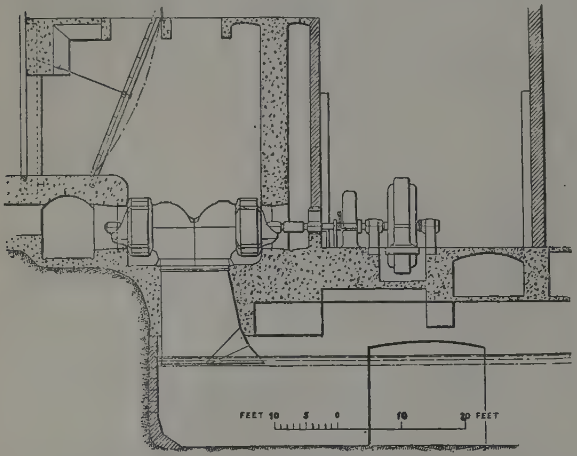


FIG. 2 HYDROELECTRIC POWER STATION AT FORSHULTEN, SWEDEN

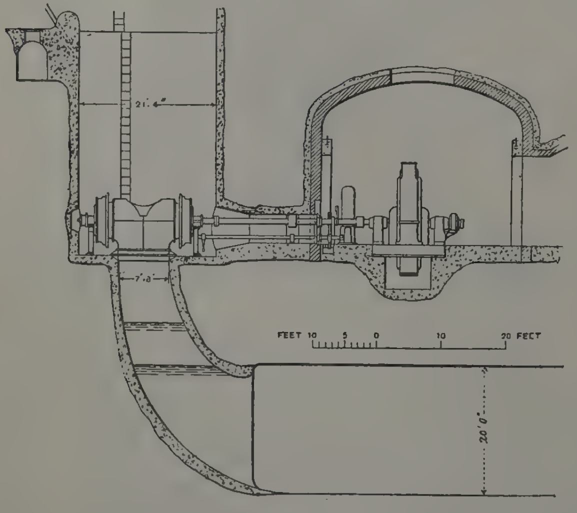


FIG. 3 MOCKFJAERDEN HYDROELECTRIC POWER STATION, SWEDEN

The power plant at Forshulten, Sweden (Fig. 2) is an example of a typical horizontal low-pressure turbine plant. The units, of which there are six in operation, each with an output of 3000 hp., are arranged with double runners on a horizontal shaft. They operate at 187 r.p.m. under a net fall of 42.6 ft., the wheels being placed in open concrete pits protected by sluice and strainer racks, the two runners discharging into a common cast-iron suction casing. The shaft is supported at each runner on two outside ring-lubricated bearings, in addition to a babbitt-lined automatically grease-lubricated bearing inside the suction casing. The practice of providing the turbines with lignum-vitæ underwater bearings has now been discontinued in favor of outside ring oil-lubricated bearings, the bearing on the inlet side being made accessible through an inspection tunnel as in the present case or through a vertical steel funnel protruding above high-water mark.

More than usual interest is presented by the arrangeemnt adopted at Mockfjaerden Hydroelectric Power Station, Sweden, on account of the power house being situated underground and using open turbines under the relatively high fall of 72 ft. The arrangement of the plant is seen from Fig. 3, and comprises four units each having an output of 5000 b.hp. at 225 r.p.m. with double runners on horizontal shafts. Each turbine is placed at the bottom of a concrete-lined shaft and discharges into the common tailrace tunnel. The powerhouse is blasted out of solid rock, the floor level being approximately 70 ft. below the surface, whereas the switchboard and transformers are housed in a separate building on ground level and communicate with the power house below through an inclined shaft. The alternators are directly connected to the turbine shaft and, due to the underground situation, special arrangements had to be made to insure sufficient cooling. For this purpose the alternators are totally enclosed and cold air is forced down a separate shaft and distributed through underground ducts to each alternator, the hot air escaping from the top of the housing and being expelled through the vertical shaft communicating with the surface.

Medium-pressure Francis turbines are classified by the author as those operating between the heads of 75 to 150 ft. A unique installation of this type of turbine is the Porjus Power Station, Sweden. As in the case of the Mockjaerden Power Station, this plant is also situated underground, but the turbines are enclosed in steel casings and placed at the bottom of the intake shafts about 160 ft. below ground level. The vertical shafts are cut through solid rock and provided with liners of steel pipes with an internal diameter of 11 ft. 6 in.; and with flanged connection to the turbine casing. There are five units with an average capacity of 12,500 hp. each under a net fall of 163 ft. running at 225 r.p.m. The turbines are of the double type with two runners, discharging into the common suction casing. The power house is also blasted out of solid rock, and is 36 ft. wide and 310 ft. long, communicating with the turbine chambers through the short tunnels which accommodate the shaft extension connecting turbines and alternators.

The roof is supported on a strong concrete arch, and by the provision of false walls and roofs leaving a space between the rock and the walls through which warm exhaust air from the generator is allowed to pass, all damp is prevented from penetrating into the power house. The generators have a normal output of 11,000 kva. and 10,000 to 11,000 volts 3-phase current. The necessary switchgear and transformers are also in this case placed in a separate building on ground level, a shaft providing communication between this building and the power house below, through which the heavy parts of the machinery can be lowered; in addition to which there is lift accommodation both for passengers and goods. The line voltage is 80,000, the power being utilized for railway traction and for mining purposes.

As an instructive example of the arrangement of the medium-pressure turbine with horizontal shaft and spiral casing, Fig. 4 shows a section through a unit of the Massaboden Hydroelectric plant used in connection with the Simplon Tunnel in Switzerland. Each unit is capable of developing 3500 b.hp. under a net head of 142 ft. at 500 r.p.m. The turbine is equipped with two runners cast back to back in one piece, the outside bearing being arranged with thrust collars to take up any unbalanced thrust in an axial direction.

The noteworthy fact with medium-pressure plants as in the case of low-pressure turbines, is that recent developments seem to favor single-runner units on account of higher mechanical overall efficiency and less foundation work, coupled with lower initial cost. The decision in each case must be made on its own merits and with a careful consideration of local conditions.

The outstanding feature in the development of the high-pressure Francis turbine is its adoption for use with increasing heads. Today Francis turbines utilizing a head of from 500 to 600 ft. are not uncommon, the highest fall for which a Francis turbine has been designed being approximately 745 ft.

The most important improvement in the Pelton wheel is in the system of regulation which was necessary for new conditions of electrical transmission, and the demand for accurate and reliable automatic governing. The inherent defect of the method of by-pass regulation being liability to stick and excessive wear, together with difficulty of insuring synchronizing action, resulted in the introduction of the deflecting nozzle. In recent years the combined spear and deflecting nozzle has come to the front and has now been adopted in most modern plants. A number of different designs of this method of operation can be traced to one of the three systems shown diagrammatically in Fig. 5. In each case the operating cylinder of the oil-pressure governor operates the deflector and spear simultaneously when opening, but by sudden closing of the governor the deflector will in the first instance cut into the jet and divert the water from the wheel until the spear by slowly overcoming the dashpot resistance, regulates the water supply corresponding to the load, when the deflector will be brought back into a position just tangential to the reduced jet. The free movement of the deflector, independent of the spear in the closing direction, is in each case permitted by the "lost motion" existing in the mechanical connection between the deflector and spear.

The principal development in the design of pipe lines has been the use of concrete for low-pressure lines where its low initial cost and durability give it a decided field of usefulness. In some places concrete pipes have been used as a pressure line when a special form of reinforcement and treatment to exclude leakage has been adopted. Wood-stave pipe line is of value because of its durability, low cost, and low coefficient of friction, and is therefore of practical advantage for the construction of the upper portion of pipe lines where suitable wood can be procured.

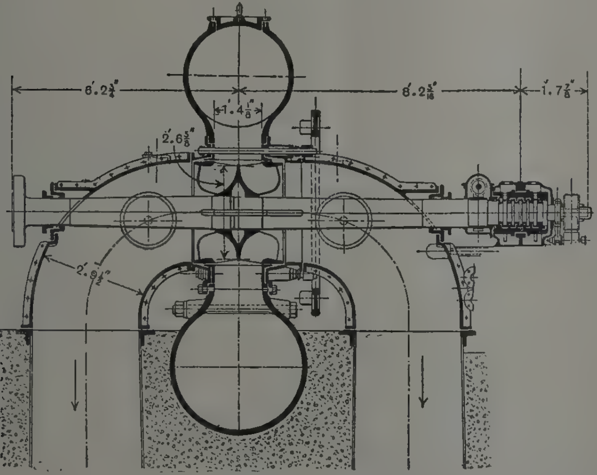


FIG. 4 ONE OF TWO TURBINES OF 3500 HP., MASSABODEN

The welded-steel pipe lines signify the most important developments in recent years because of the progressive utilization of high heads requiring close study of pipe-line construction. Welded pipe lines are exclusively used for high-pressure installations on account of their superior strength and absence of rivets which obstruct the flow of water. Welded pipes are heated by means of water gas and welded under high-speed, mechanically driven hammers which produce a weld of approximately 95 to 97 per cent of the strength of the full plate. After welding the pipes are annealed to remove all internal stresses. The foregoing process is only suitable for material up to about 1¼ in. thick, as above this thickness the heat would not penetrate sufficiently to produce a uniform welding heat. For larger plate thickness, the "wedge-welding" method is resorted to, the edges being brought together and a separate bar inserted, forming the weld. With this method pipes up to a thickness of 1¾ in. can be satisfactorily welded. The material used in welded pipe lines is best open-hearth steel, with a tensile strength of 56,000 lb. per sq. in. and a elongation of 20 to 25 per cent in 8 in. On account of pressure surges plate thicknesses are calculated with a factor of safety of from 4 to 5, based on the strength of the weld equal to 100 per cent. Pipes are made in lengths of an average of 18 to 20 ft., using riveted joints for medium pressures and flange or expansion joints for high pressures. In the riveted, or so-called "bump" joint, the pipe ends are swelled so that the rivet heads do not obstruct the free area of the pipe.

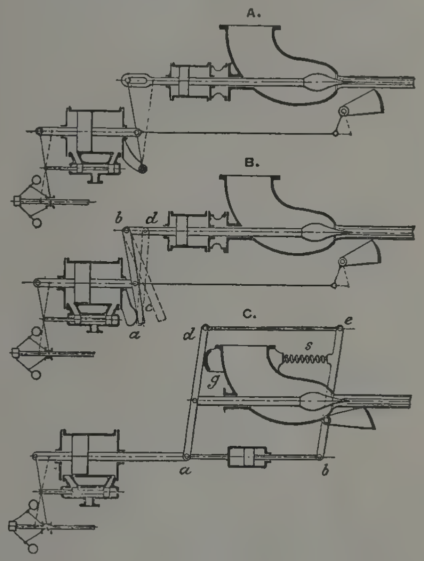


FIG. 5 SYSTEMS OF REGULATION FOR PELTON WHEELS

A further improvement in the art of welding is reinforced welded pipe, consisting of a number of solid forged rings shrunk on to the outside of the pipe and adding further strength to the pipe with a reduction of plate thickness. This innovation in pipe design permits, for high heads, the use of a larger-diameter pipe without exceeding the maximum limit of plate thickness to obtain a reliable weld, thus reducing the number of pipe lines for large installations and the initial cost of installation. Although the present method of manufacture permits only short lengths of reinforced pipe to be made, these may be welded together with a circumferential weld into lengths of about 18 ft. In high heads this method of pipe-line construction makes an appreciable reduction in the initial cost of the development.

In his conclusion, Mr. Bergstrom shows the results of an estimate of the available horsepower in the principal countries of Europe and America. In the United States 28,100,000 hp. are shown as available, 24.9 per cent of which has been developed; 2,000,000 in Switzerland, of which 25.5 per cent has been developed; 4,000,000 in Italy, of which 24.4 per cent has been developed. Lowest percentages of development have been in Great Britain, with 8.3 per cent of 963,300 hp.; Spain, with 8.8 per cent of 5,000,000 hp.; and Austria-Hungary with 8.8 per cent of 6,460,000 hp. These figures apply, as stated above, only to Europe and the United States of America, and do not include the vast resources in white coal of Australia, Asia, Africa and the South American continent. (*Journal of the Institution of Mechanical Engineers*, Feb. and Mar. 1920, pp. 55-151, 51 figs. Also in *Engineering*, Jan. 30 (pp. 140-143), Feb. 6 (pp. 191-195) and Feb. 13 (pp. 227-232), 1920, from which journal the illustrations here used have been reproduced.)

The Kaplan Hydraulic Turbine

THE Kaplan turbine, designed by Professor Kaplan of Brünn, Austria, is a development of the Francis type. In a Francis turbine the water acquires a certain predetermined velocity and direction, and then flows under the turbine wheel where it is deflected by the runner blades in such a manner as to pass into the suction pipe as far as possible without loss. The Francis turbine belongs to the class of pressure turbines; that is, the water possesses a certain excess pressure before it enters into the turbine wheel, and the pressure head is only partly converted into velocity in the guide apparatus.

The efficiency of the turbine depends, therefore, upon the blade angle and this latter in its turn is determined by the necessity of providing for the entrance of water as free of shock as possible. This again is accomplished when the runner blades are inclined with respect to the circumference of the runner in the direction of the flow of the entering water. In other words, if the water (Fig. 1) enters from the guide apparatus into the runner with the velocity of w_1, then it has only a velocity v_1, relatively to the runner moving with the peripheral velocity μ_1. The angle between μ_1 and v_1 is the true angle of entrance with respect to the runner blade. By varying this angle, it is possible to vary the velocity of rotation of the turbine within certain limits, acute angles giving low velocities of rotation, and large angles high velocities of rotation, while the so-called normal runners require right angles. In addition to this, slow-running turbines are built with runners of as large a diameter as possible, and fast-running turbines with runners of small diameters. In this way various types of turbines with their characteristic design are secured, and the original article gives illustrations of two such runners, one for slow speed and one for high speed.

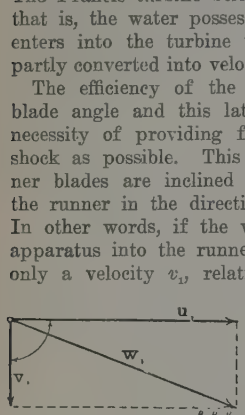


FIG. 1 VELOCITY DIAGRAM OF MEDIUM-SPEED FRANCIS TURBINE

It has been usual heretofore in designing the runner blades to divide the turbines into so-called elemental turbines and to determine the proper dimensions of cross-sections for each line of flow, assuming the flow to be as free as possible from losses.

It is claimed that Professor Kaplan has entirely deserted all these rules based on the so-called theory of "water-filament flow." He, in his theory of turbine design, attaches as much importance to the question of friction, which has been hitherto practically neglected, as has been done by others to the character of flow. According to his theory, other conditions being similar, it is the number of blades that has the determining importance. If it is too small, the flow of water suffers, and if it is too large, then the efficiency is reduced.

In an effort to create a turbine of maximum speed Professor Kaplan in the first place shortened as much as possible the length of the blades. Furthermore, he found that a large runner clearance does not harm in any way. This led him to locate the blades further and further back of each other until he obtained a runner having only actual flow. Finally, it is claimed that he succeeded by proper selection of the suction pipe in reconverting a large amount of the energy of the water at discharge into pressure.

All these changes led to the design of the new form of turbine such as is shown diagrammatically in Fig. 2. Contrary to what happens in a Francis turbine, the water flows throughout through the runner in an axial direction and the deflection of the water in the runner is eliminated. The guide apparatus is designed in the same manner as in the conventional Francis turbines, but the vanes are so arranged that the water discharges not only along the longitudinal edges, but also at the front edges. The guide-wheel cover has been made flat. According to the prevailing opinion, the water left to itself after its exit from the guide apparatus should lose most of its velocity through turbulence in the annular space formed by the flat cover, and at first glance it would appear that the dead space at E would unfavorably affect the flow of water. The two lines of flow S_1 and S_2 show, however, in what a powerful manner the water is deflected between the guide wheel and the runner.

It is claimed that the Kaplan turbine has several advantages of design, of which the following may be mentioned:

The turbine shaft can have its bearings located nearer the center of gravity of the runner than is the case in the Francis turbine. This results in a stable, comparatively light construction, avoiding the difficulties due to unbalancing which are encountered in Francis high-speed turbines.

The runner is somewhat smaller in diameter than the draft tube at its narrowest place. This makes it possible to insert the runner into the casing both from the draft-tube side and from the guide-wheel cover side, contrary to what is the case with high-speed turbines, which can be installed only from the draft-tube side, which is not always easy to do.

The diameter of the runner boss can be kept comparatively small; likewise the free blade area F is considerably smaller than in the Francis turbine. The weight of the Kaplan runner is therefore very much smaller, in fact, it is claimed to be on the average only about one-fifth of the weight of a Francis wheel of the same diameter. Furthermore, the difficult method of holding the blades is eliminated, as a result of which it is claimed that a Kaplan runner can be made in about one-fourth the time required to make a Francis runner.

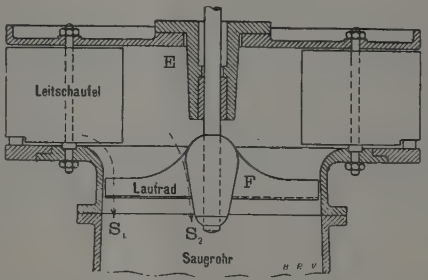


FIG. 2 SECTIONAL VIEW OF A KAPLAN TURBINE
(*Leitshaufel*, guide vane; *Laufrad*, Runner; *Saugrohr*, Draft tube.)

The principal advantage of the new construction is claimed to lie, however, not in these advantages affecting construction, but in the fact that with a Kaplan turbine speeds become attainable which are beyond the capacity of the Francis turbine, in addition to which the efficiency of the turbine at various loads varies in a more advantageous manner than with the conventional turbines. These points are further elucidated in the following manner:

It is important to have hydraulic turbines run at as high a speed as possible, because this permits a more economical utilization of the electrical generators usually connected to them; and it appears that the most economical speed of rotation for the generator is from 200 to 300 r.p.m. for power outputs of from 500 to 5000 hp., and from 400 to 600 r.p.m. for power outputs of from 100 to 500 hp.

These speeds are beyond the range of Francis turbines, unless the head of water is very large and the volume of water small. This results in uneconomical plants for low water heads, and in illustration a calculation is given showing that in a low-head plant with a turbine having an output of 5000 hp. and running at 83 r.p.m., the generators at peace-time prices would cost 150,000 marks (say $37,500), while if the turbine could be run at 250 r.p.m. the cost of the generators would be only 100,000 marks (say $25,000). Furthermore, the high-speed turbine, all else being equal, would be built much cheaper than the low-speed machine.

The low-speed machine is uneconomical from another point of view: namely, that where large volumes of water have to be handled a large number of units have to be used, since otherwise the velocity would have to be excessively low and the units excessively large. Numerous small units, however, are always more expensive than a few large ones.

A good insight into the question of the speeds available with various turbine types is obtained by employing the conception of "specific speed," which may be called "unit speed." In this the volume of water handled and the head of water for a given turbine are eliminated, and a unit speed determined for a given type of runner. By such a unit speed is understood the speed at which a machine similar in construction to the given turbine would have to run when delivering 1 hp. under a head of 1 m. If a turbine delivering N hp. with a head of H runs at n revolutions per minute, its unit speed of rotation is

$$n_s = n\frac{\sqrt{N}}{H\sqrt{H}}$$

The following unit speeds are given for the conventional types:

12 to 50 for Pelton wheels
50 to 100 for Francis slow-speed wheels
100 to 200 for Francis normal-speed wheels, and
200 to 300 for Francis high-speed wheels.

As compared with these, a very much higher figure is possible with the Kaplan turbine: The first of these turbines built in Sweden had unit speeds of from 500 to 600, the turbine tested at the Technical High School in Brünn, 900, and in recent tests speeds of 1200 to 1600 have been obtained with good efficiency.

Efficiency of Turbines

Francis turbines have a very high efficiency, exceeding 80 per cent. This efficiency depends, however, on the type of the turbine, high-speed turbines having usually poorer efficiency than low-speed. Fig. 3 shows how the efficiency varies at various loads for a Francis turbine running with a unit speed of about 200. As is usual, this turbine has been designed to work with an average volume of water equal to three-fourths of the maximum volume, and at 0.75 load it attains its highest efficiency, which falls off materially with smaller load.

If this is compared with the brake diagram of a Kaplan turbine built in Sweden (Fig. 4), it can be seen that notwithstanding the high unit speed, namely, 750, the efficiency is not only very good in itself, but remains practically the same over a range of from about one-half to full load.

In this connection the curve shown in Fig. 5 is of considerable interest. This was secured from a brake test of a turbine installed in lower Austria and designed to operate at a unit speed of rotation of about 700. The wheel has a diameter of only 600 mm. and was designed to deliver about 35 hp. with 1.1 cu. m. of water per second and a head of 3 m. As shown by the curve, the efficiency rises from full load to one-half load, and even at 40 per cent. of the specified volume of flow it is still close to 83 per cent. Brake tests were made on the turbine under the same load but with various heads of water and various speeds of rotation and these tests have also shown a remarkable uniformity in efficiency.

This lack of sensitiveness of the Kaplan turbine to variations in the volume of flow and in the head is particularly important in low-head installations, as it makes it possible to build the turbine for the maximum available volume of flow and then operate on smaller volumes and yet attain a high efficiency. In addition to this, it is not necessary to go to the trouble of providing high-water reserves as the Kaplan turbine can very well stand overloads.

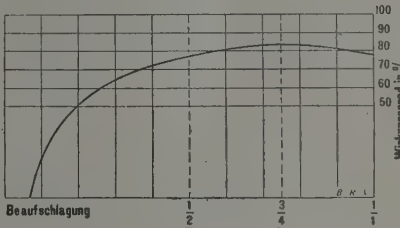


Fig. 3 Efficiency of a Francis Turbine $n_s = 200$

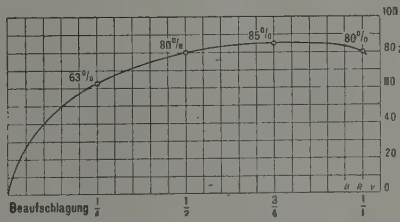


Fig. 4 Efficiency of a Kaplan Turbine $n_s = 750$

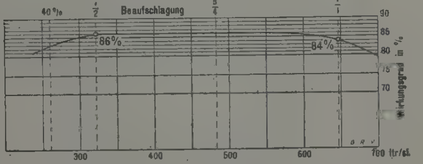


Fig. 5 Efficiency of a Kaplan Turbine $n_s = 700$
(*Beaufschlagung*, load; *Wirkungsgrad*, Efficiency; 1*tr./sk.*, liters per sec.)

An interesting feature of this type is that in many cases it is very easy to convert a conventional Francis turbine into a Kaplan turbine, for only the runner has to be changed, the guide apparatus remaining the same. (*Zeitschrift des Bayerischen Revisions-Vereins*, vol. 24, no. 9, May 15, 1920, pp. 71-73, 7 figs.)

Hydraulic Section of Report of the National Electric Light Association Committee on Prime Movers

The important feature of the past year's development is the increased size of water wheels installed. The growth of operating systems makes feasible this increased size, individual units of approximately 40,000 hp. capacity having been installed and larger ones being contemplated. One large manufacturing company reports the starting of a total of nearly one-quarter of a million kilowatts in large hydroelectric generators in units of over 12,000 kw. each. In addition there are a large number of smaller vertical direct-connected wheels being installed as additional or replacement units.

Progress and Development of Hydraulic Prime Movers

The tests of the large water wheels in place show remarkably high efficiency, which makes it profitable in a great number of cases to replace old installations with new. The new large units are uniformly distributed over the United States. Many of the older hydraulic developments which used dams and canals, supplying widely scattered individual water wheels, are now planning a single hydroelectric station to utilize the entire fall and transmit the power electrically.

Several large units have been started and continuously operated for over a year without a single shutdown on account of wheel troubles.

A new type of water wheel for low-head plants using an exceptionally high-speed runner has been developed by Forrest Nagler of the Allis-Chalmers Company.

Four 15,000-hp. tangential wheels for operating under an effective head of 1008 ft. have been ordered by the Great Western Power Company. These wheels contain 21 buckets, each 36 in. wide and 24 in. deep, and water is supplied from 13 nozzles. They are to operate one each overhung from the ends of a 22,200-kva. generator shaft running at a speed of 171.4 r.p.m. It may be of interest to state that several water-wheel manufacturers designed and recommended Francis-type wheels for this head at a speed of either 600 r.p.m. or 750 r.p.m. The operating engineers, however, were afraid that the erosion on the clearance passages and gate mechanism might be rather severe when operating under a pressure of over 430 lb. per sq. in. This, coupled with the fact that it would require a turbine-type generator with smooth-core field which was not suited for charging conditions on their long transmission line, led them to choose the impulse wheel.

There are at present under construction some 800-ft. Francis wheels for the Southern California Edison Company, to be run 600 r.p.m. and deliver a maximum horsepower of 22,500.

Automatic hydroelectric plants are receiving considerable attention. These plants operate without attendants, and the gate openings and output are regulated according to the water supply available, by means of a float control from pond level. These plants may be tied into a local power system or be run in connection with a steam station which takes care of the fluctuation of load and varying flow of stream.

There is a radical tendency, where climatic conditions are favorable, to confine the power-station building to the housing of control apparatus only, locating generating apparatus, step-up transformers and high-tension equipment outdoors.

General practice is divided between the centralization of auxiliaries and a tendency to make each large unit self-contained with its own exciter, governor, pumps, etc. A satisfactory solution of this problem is accomplished by having individual speed-control sets for each of the main units and by having an emergency pipe connection from each individual set to each adjacent set. Each main oil-pressure set is of sufficient size to operate two main units under emergency conditions. Thus all of the advantages of the central oil-pressure system are combined with the advantage of the individual system.

HYDRAULIC OPERATION AND COMBINED OPERATION OF HYDRAULIC AND STEAM PLANTS

The combined operation of hydroelectric and steam-electric generating stations has become a subject of vital interest to the central-station industry. It will be increasingly important in the future, since the marked trend toward interconnection will bring more and more steam plants into parallel operation with hydraulic plants, and will make possible the development of water powers which cannot now be utilized economically. Yet intensive study of the subject is comparatively new. Individual companies and systems have made more or less careful analyses of their own conditions and problems, but there has been little information exchanged or published. During the past year the committee has considered or has had brought to its attention a large number of problems. These are listed below with the idea of having before the committee an outline to be followed in future work.

The problems of combined operation and hydraulic operation may be classified under the three heads outlined below: namely, (1) problems of the combined system; (2) problems of the steam plant; (3) problems of the hydraulic plant. Some problems of purely hydraulic operation are included in the third group, although they do not depend on combined operation.

I—PROBLEMS OF THE COMBINED SYSTEM:

A—Parallel operation of coöperative systems:

1 Contract relations between hydraulic and steam plants
2 Advantages and disadvantages of interconnection
3 Division of load between hydraulic and steam plants
  (*a*) High-flow operation
  (*b*) Low-flow operation
4 Division of wattless current between hydraulic and steam plants
5 Frequency regulation and governing
6 Relative reliability of hydroelectric and steam-electric service.

B—Parallel operation of non-coöperative systems:

In this group there are other problems which are chiefly electrical and do not fall within the scope of the Prime Movers Committee, but it should be mentioned that a complete study of combined operation would include the following problems: Increased damage to property and interruption to service which may result from greater capacity feeding in so short-circuits; protective methods; the use of reactance to limit short-circuit currents; the effects of such reactance on voltage and synchronizing power; voltage regulation; synchronizing power of tie lines.

II—PROBLEMS OF THE STEAM PLANT:

1 Standby service
2 Minimum load on steam turbines
3 Time required to start up steam turbines
4 Shutting down steam plant during "off-peak" hours
5 Banking practice as related to combined operation
6 Novelties and difficulties in operating
7 Station design as affected by combined operation.

III—PROBLEMS OF THE HYDRAULIC PLANT:

1 Efficiency measures to secure maximum output or water economy.
2 Measurement of water
3 Dispatching of water and hydrographic methods
  (*a*) When the water is used by only one plant
  (*b*) When the same water is used by two or more plants
4 Ice troubles and methods of fighting same
5 Power requirements and operation of auxiliaries
6 Planning of maintenance, inspection, and repairs
7 Operating rules and procedure
8 Novelties and troubles in operating
9 Station design as affected by combined operation.

From this analysis of the problems of the combined operation the report considers the points in detail, outlining the information required for further reports and giving some data that have been discovered in the solution of the subdivisions of the problems. The report states that every system must constitute a separate problem, but it is believed that many principles and conclusions will have a common application to a large number of systems. In abstracting the remainder of the report, material will be included only where new information has been submitted.

I—PROBLEMS OF THE COMBINED SYSTEM: A—PARALLEL OPERATION OF COÖPERATIVE SYSTEMS

1 *Contract Relations Between Hydraulic and Steam Plants.* The ideal in every combined system should be minimum overall cost of delivery to the ultimate consumers. The solution of the problem, where hydraulic and steam stations are separately owned, lies in some sort of flexible arrangement on a coöperative or cost- and profit-sharing basis in which rigid limits of power and energy are disregarded and the maximum output of the hydraulic plant is utilized as far as possible. Such a solution furthers the conservation of our natural resources in which the central-station industry is vitally interested.

3 *Division of Load Between Hydraulic and Steam Plants.* Under this head the report calls attention to some instances where steam generation is necessary in spite of the fact that the hydraulic plant is carrying the load. Such steam generation may be necessary for maintenance, economy or safety of steam-plant equipment, or reliability of service. Unnecessary steam generation may be caused by faulty governing or load dispatching. Under a discussion on the unnecessary steam generation due to faulty governing or load dispatching, the report points out the necessity for a graphic meter giving total station out-

put for each generator station, and the necessity of means of communicating output figures from all generating stations to one central point.

The importance of not having the hydraulic capacity of the turbine limited by the generator capacity is also emphasized.

4 *Division of Wattless Current Between Hydraulic and Steam Plants.* In the case of a hydraulic plant operating in parallel with the steam plant, the problem consists of comparing aggregate steam costs for high load factor but increased steam generation due to hydro losses, with steam costs for a poor load factor but a smaller amount of energy output. If the hydro plant has large storage or high head and little tailrace backwater, so that the reduction in head due to low load factor is not great, it will usually be found that it is most economical for the hydro plant to take the poor load factor. The result may be reversed if the percentage loss of delivered output from the hydro plant is considerable and if the percentage increase of steam costs due to lower load factor and variations is negligible.

6 *Relative Reliability of Hydroelectric and Steam-Electric Service.* The report is quite positive in its statement that in recent years particularly, the individual hydraulic prime mover is more reliable than the individual steam turbine. The present-day single-runner vertical-type water-wheel-driven generator equipped with a Kingsbury bearing seems to give almost perfect continuity of service. It has been nearly always found that hydro service can be restored before the steam plant can pick up a large proportion of the load even with a number of boilers held ready under "hot bank." As a result, with modern conservative construction of transmission lines, there is very little pure stand-by service in the East and Middle West. On the Pacific Coast, where use of fuel oil makes quick firing possible and transmissions of great length with considerable inherent voltage drop, extensive stand-by service is more common.

II—PROBLEMS OF THE STEAM PLANT

1 *Stand-by Service.* It is stated that in coal-burning plants underfeed stokers with forced draft and fan and ram speed control, or chain grates with forced draft may be found most satisfactory for quick starting. Future developments will be along the line of using oil and coal under the same boiler, and of adapting pulverized fuel for large central-station use.

The example of the municipal plant of Zurich, Switzerland, is cited as demonstrating that during off-peak hours stand-by boiler pressure may be supplied electrically from the hydroelectric plant. In this case, the use of electricity for which there was no market was more economical than paying for banking coal.

2 *Minimum Load on Steam Turbines.* Motoring, even with a certain amount of steam entering the turbine, dropping below a certain minimum turbine load, and sharp fluctuations of load are regarded as injurious to large high-speed steam turbines by many operating engineers in Eastern plants.

On the Pacific Coast, however, the steam turbines have been floated on the line with practically no load, and in some cases, as synchronous condensers, with less than no load steam entering the turbine without apparent damage.

4 *Shutting Down Steam Plant During "Off-Peak" Hours.* To avoid the difficulties caused by accumulation of water in pipe lines and leaky joints, occurring in the steam plant during shutdowns, some plants operate at least one boiler at near normal rating during the off-peak hours and use the steam thus generated to operate a small unit, circulating the steam through all the steam mains before it reaches the unit. In other cases the generating plant is shut down entirely, but steam is blown off for some time near the turbine inlet before the unit is started up.

5 *Banking Practice as Related to Combined Operation.* A steam plant carrying the peak loads of a combined system operates at a poor load factor and therefore has an increased amount of banking. The report gives the result of a 42-hour banking test on a 822-hp. Stirling boiler with underfeed stokers as 0.112 lb. of 13,500-B.t.u. coal per rated boiler hp. banking hour. The pressure being allowed to drop about 15 lb. below normal, coal was added after $16\frac{3}{4}$, $23\frac{3}{4}$ and 40 hours. The steam generated after the bank had nominally begun was approximately measured and an equivalent amount of coal deducted. In a similar test on oil-burning boilers a value of 0.046 lb. of oil per hp-hour was found. This is equivalent in heating value to 0.063 lb. of 13,500-B.t.u. coal.

6 *Novelties and Difficulties in Operating.* The percentage changes in load on steam plant are very greatly increased when the hydro plant takes flat load during high flow. This condition makes a foreknowledge of load variations essential to avoid excessive blowing off through safety valves or reduction of hydraulic output. To assist in estimating load in the boiler room, the Ashley Street Station of the Union Electric Light and Power Company of St. Louis operating in parallel with the Mississippi River Power Company and equipped with a number of varying sizes and types of generating units of which a kilowatt load does not give an accurate idea of the boiler room, has adopted a novel unit called the "kilber." The kilber is 1000 lb. of steam per hour. The boiler room is regulated by the number of kilbers required, an estimate which is furnished from the switchboard at half-hour intervals.

III—PROBLEMS OF THE HYDRAULIC PLANT

1 *Efficiency Measures to Secure Maximum Output or Water Economy.* The report contains a detailed consideration of the operation of the Holtwood Station for information under the above heading. This station operates most of the time in parallel with one, frequently two, and rarely with three, steam-generating stations. Energy is transmitted at 70,000 volts to Baltimore, Md., 40 miles distant, and to Lancaster, Pa., 15 miles distant.

The Holtwood Station is on the Susquehanna River, the flow of which varies from about 3000 to about 700,000 cu. ft. per sec. The average height of the dam is about 55 ft. and flashboards of a height of $2\frac{1}{2}$ ft. or $4\frac{1}{2}$ ft., according to the season, are usually installed on the crest. Except during high floods and extreme low flow, the working head varies from about 47 ft. to 62 ft. The area of the pond at the elevation of the dam crest is less than four square miles. There are eight main turbines of the vertical-shaft, inward and downward flow Francis type. The total of the turbine ratings is 118,000 hp. (ratings are not, however, at the same head). The actual maximum sustained capacity of the plant is about 83,000 kw. Seven of the turbines are set in wheel pits with two runners per shaft. The eighth and newest unit is a single-runner turbine set in a reinforced-concrete scroll case.

Tailrace conditions are such that, with no flow over the dam, the tailrace elevation at the power house is about 14 ft. higher at full load than at no load. (*Report of Committee on Prime Movers,* presented at 43d Convention of the National Electric Light Association, May 18-22, 1920, pp. 105-128.)

Short Abstracts of the Month

ENGINEERING MATERIALS

STUDY OF IMPACT TESTS ON ALLOYS, Austin B. Wilson. Impact tests are of interest as comparatively little is known of the properties of metals under this type of stress. In the present case tests were made of three distinct classes, namely, McAdam impact-shear tests with unnotched bars, Fremont direct impact tests with notched bars, and Landgraf-Turner alternating-impact tests.

Several series of tests of each kind were made. At first machined bars were used, but the tests indicated that it was not necessary to machine the bars. Second, the bars were heat-treated by quenching from 920 deg. cent., reheating to 600 deg. cent., and furnace-cooling. This, it was thought, would increase the resistance to impact-shear, but such was not the case. In

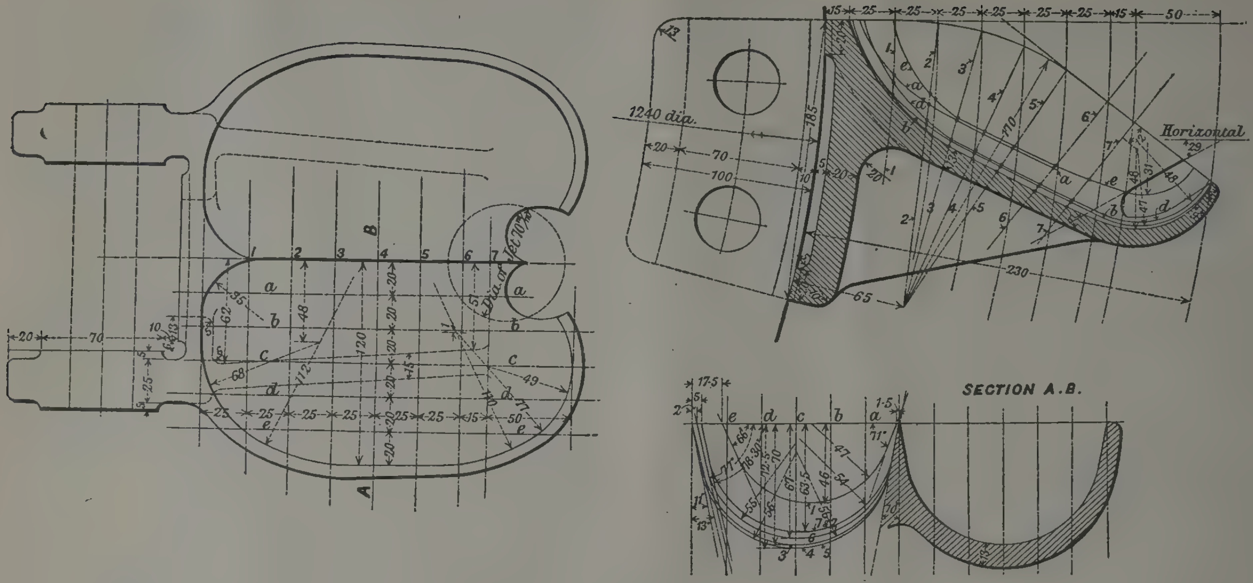


Fig. 1 Layout for Pelton Turbine Buckets

general, it was found that the aluminum bronzes tested excelled any of the other bronzes of the series in resistance to impact by shearing.

Aluminum bronze also showed high resistance to direct impact where *notched* effect was present; likewise it surpassed other bronzes in resistance to failure through fatigue.

Data of the tests are presented in the original article in the form of tables but no analyses of the materials tested are given. (*Foundry,* vol. 68, no. 352, August 1, 1920, pp. 616-617 and 622, 3 figs., *e*)

HYDRAULIC ENGINEERING

Pelton-Wheel Bucket Design

Pelton Wheel Reconstruction, Percy Pitman. Description of a reconstruction carried out during the war period. The work was difficult as it had to be carried out on the turbine as it stood in the power house and only the top cover could be removed, which made the position in which to work very cramped.

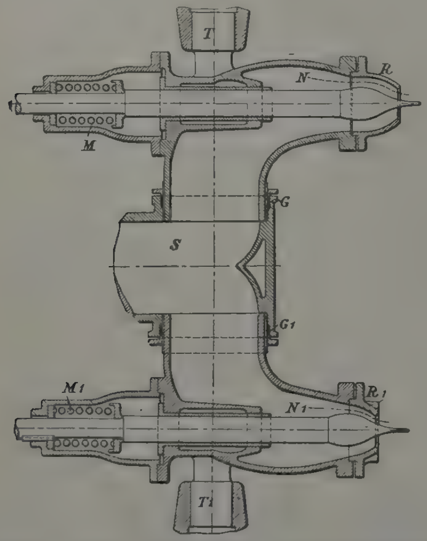


Fig. 2 Percy Pitman Governor for Pelton Water Turbine

The turbines were of the Pelton type made by Ganz and Company of Budapest, and were installed in 1907, to work with a head of water of 1010 ft. Each Pelton wheel consisted of two 4-ft. diameter steel disk runners and each wheel was fitted with 22 staggered buckets. Both the buckets and the needle and nozzle were of an extremely bad shape and were continuously breaking, which was particularly dangerous in view of the high peripheral velocity employed.

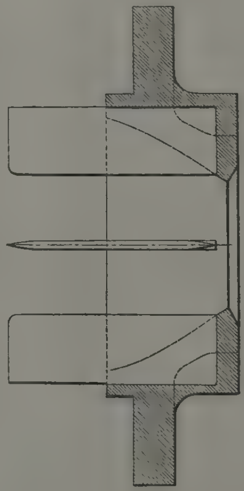


Fig. 3 Experimental Nozzle for Use in Pelton Water Turbine

The portion of the paper describing the new installation is of particular interest because it presents a complete layout for the new buckets, a thing not often found in engineering literature.

The bucket, Fig 1, is of the usual Pelton shape with the exception that it is slightly curved on the dividing wedge, and also on the bottom face of the bucket in a radial direction. The purpose of this is to give a larger radius of effective action after the bucket has passed the theoretically best position; that is, when the bucket face is at right angles to the entering stream.

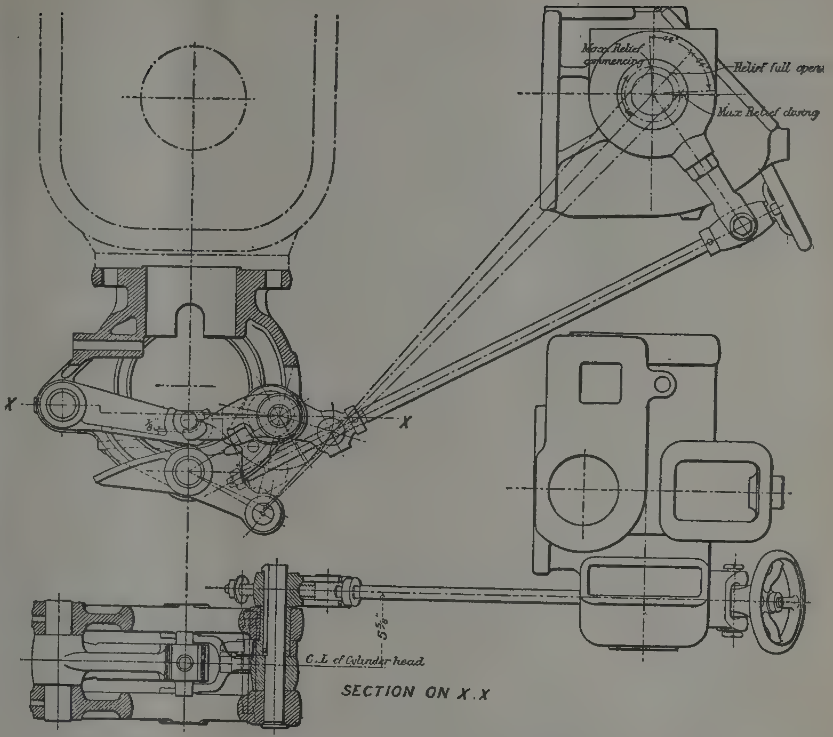
The drawings show the points from which the various radii are struck. The methods of setting out shown are applicable to almost the whole range of impulse waterwheels, providing load conditions, head of water, size of nozzle, and speed required are taken into consideration.

The author designed a separate governor for the automatic regulation of the needles to enable the plant to take care of load changes, and at the same time economize water. This is shown in Fig. 2. The bad stream lines made by the existing steel nozzles R are shown by dotted lines N. The new bronze nozzles R_1 give a much straighter path N_1 through the nozzles. T and T_1 are the trunnions and G and G_1 the glands, while S is the T-shaped supply pipe. The springs M and M_1 shown in Fig. 2 were designed to improve matters, but unfortunately up to the present the plant could not be spared the necessary length of time to carry out such a desirable improvement. The old Ganz buckets, needle and nozzle with 420 lb. pressure on the gage gave 970 kw. corrected, and the new buckets with the existing steel nozzle and spear (which was not made by the writer) gave 1082 kw., and after allowing a substantial correction factor of 4 per cent, it showed an increase of 70 kw., or a net increase in efficiency of 7.3 per cent.

Experimental nozzles were also made of bronze, into which were dovetailed four rustless-steel blades which were ground and highly polished up to a thin knife-edge on the inside, as shown in Fig. 3. These nozzles proved to be a big improvement, producing a jet of extraordinary solidity and transparency, the water for about 2 ft. issuing almost like a glass rod. The electrician in charge of the power station claimed that there was an increase of efficiency of 5 per cent due to this improvement.

Ordinarily the swinging or rotative character of the stream produced great vibration which seems to have produced fatigue of some sort in the steel blades, causing them to break off short at different intervals after they had been in use for some months.

An intensive analysis of the defects of the turbine as it existed previous to reconstruction is given in the original article. (*Engineering*, vol. 109, no. 2843, June 25, 1920, pp. 851-853, 13 figs., *dp*)



FIGS. 4 AND 5 FUEL PUMPS AND VALVE GEAR

INTERNAL-COMBUSTION ENGINEERING

Cold-Starting Oil Engine

SOLID-INJECTION RUSTON AND HORNSBY CRUDE-OIL ENGINE. The Ruston and Hornsby engine is of the so-called cold-starting type, and depends upon the heat of compression for the ignition of the charge. It is claimed that a fuel consumption of below 0.4 lb. of fuel oil per b.hp. at full load has been obtained without difficulty.

The engines are built of the single-cylinder type in 11 sizes, ranging from 15 b.hp. to 170 b.hp., and of the double-cylinder type in 5 sizes, from 100 b.hp. to 340 b.hp.

The fuel pumps and valve gear for both cylinders are driven from a single lay shaft running along the right-hand side of the engine, the eccentric operating the inlet, and exhaust valves being keyed on the extreme end of this shaft. The motion of the eccentric is transmitted to the valves by means of rolling levers (Figs. 4 and 5) which give a more rapid opening and closing motion than would be obtained by the eccentric motion alone. The small handwheel seen near the eccentric is for the purpose of relieving the compression by raising the exhaust valves slightly from their seats.

When working with the lowest grades of tar oil, it is necessary, in order to insure proper ignition of the charge, to inject just ahead of the main charge a very small quantity of crude or other more inflammable oil. This only amounts to about 5 per cent of the total fuel consumption at full load. It is called the pilot oil and is forced to the atomizer independently of the main supply by means of a separate cam-driven pump.

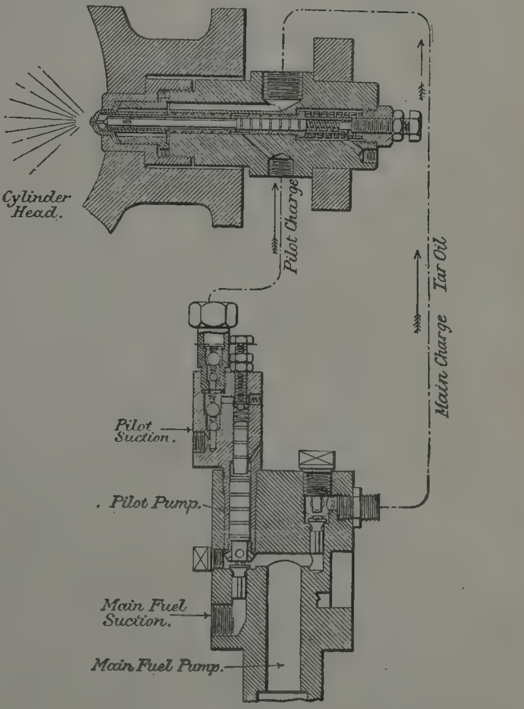


FIG. 6 ATOMIZER AND DOUBLE FUEL PUMP, RUSTON AND HORNSBY HEAVY OIL ENGINE

The construction of the atomizer and double fuel pump is shown in Fig. 6. The single main pump primarily deals with the main supply of tar oil. It takes in fuel through the main suction valve and delivers it to the atomizer through the discharge valve in the usual way. The by-pass valve controlled by the governor is not shown.

Above the main suction valve is the pilot valve, which consists of two plungers of different diameters, the lower and larger one being acted upon by the pressure of the main fuel. At every stroke of the main pump the upper and smaller plunger is raised against the action of the spring by the pressure of the fuel oil on the lower one. The upper plunger therefore acts as another pump on its own account, and by means of its own suction and discharge valves it forces the pilot oil through the atomizer separately from the main supply.

With such an arrangement the amount of pilot oil delivered at every stroke can be regulated by varying the stroke of the pilot pump. Also, the pilot oil is necessarily injected immediately in advance of the main fuel oil, which is the required condition. (*Engineering*, vol. 110, no. 2844, July 2, 1920, pp. 7-10, serial article, 22 figs., *d*)

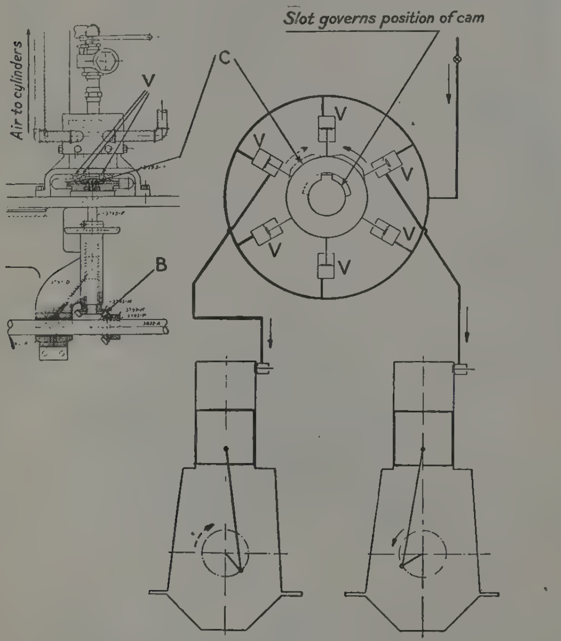


Fig. 7 Air-Starting Mechanism of the Ingersoll-Rand P-R Oil Engine

American Heavy-Oil Engine, Intermediary Between Diesel and Semi-Diesel

Ingersoll-Rand P-R Oil Engine. These engines are of the heavy-oil type and yet neither straight Diesel nor hot-bulb. The P-R is of the low-compression self-igniting type, but without hot plate or hot spot.

The engine is started by compressed air through a distributor (Fig. 7) which consists of six air valves *V*, one for each of the cylinders. Below these air valves is a cam *C* which is operated by a gear *B* from the side shaft. When the air is turned on, the six valves are driven down by the air against the action of springs and are closed, with the exception of one valve which strikes the top of the cam. This valve being held open by the cam, permits the air to pass to the cylinder which it controls. The engine turns in a given direction and the cam likewise turns, opening each valve in succession. To reverse the engine, it is stopped, the cam is moved to its opposite position, and the air valve opened.

When the engine is absolutely cold, the ignition at the start is assisted by means of a small electrical starting element located in the combustion chamber and heated to a dull red. This heating element is used only for a few revolutions and then discontinued. It does not act as a hot point or hot bulb, and after the engine is warmed up, the heating element may be removed and the engine started again without it.

Ignition of the fuel when the engine is in operation is produced by combination of a combustion chamber of peculiar shape, arrangement of spray nozzles, and timing of fuel injection. As regards this latter, it is stated that the intake valve is closed by the valve spring, the piston in its turn compressing the air from the cylinder into the combustion chamber to a pressure of approximately 200 lb. per sq. in. Injection of the fuel starts near the end of the stroke and is completed before the piston has reached the end of its travel. The solid system of injection is used. (*Automotive Manufacturer*, vol. 62, no. 3, June 9, 1920, pp. 7-12, 6 figs., *d*)

MACHINE SHOP

Hints for Working Monel Metal

Working Monel Metal, Hugh R. Williams. Monel metal cuts like no other metal. In fact, so far as cleaving action of the cutting tool is concerned, it is more like brass than like steel. It is removed in ribbons and because of its toughness, high-speed-steel cutting tools with keen edge and decided rake have to be used.

For monel-metal cutting only the better grades of high-speed steel should be employed. As a general rule, monel metal can be machined dry, though cutting lubricants and cooling solutions may be necessary for fine work. Table 1 gives a list of such lubricants for monel metal.

Monel metal can be machined effectively at a wide range of cutting speeds from a slow speed of 8 ft. or 10 ft. per min. with a heavy cut and feed to as high as 250 ft. per min., with a light cut and feed, provided ample power is available. As a rule, on general work a speed of 50 ft. or 60 ft. per min., with a ⅛-in. cut and a 1-32-in. feed, will be found to be satisfactory, but if a high finish is desired the depth of the cut should be decreased and a higher cutting speed employed, care being taken to keep the tool sharp.

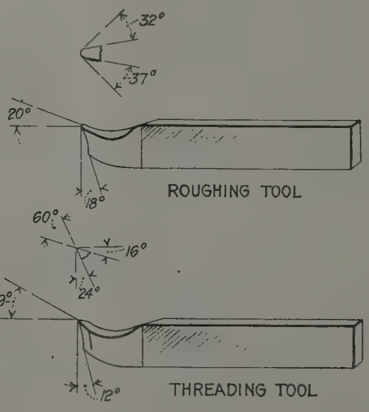


Fig. 8 Tools for Working Monel Metal

The following instructions are given for polishing and grinding monel metal:

Castings. (1) Use a solid stone, of which there are several grades and makes. The Norton Company's grade "Q," grain No. 20; and Carborundum Company's grade "G," grain No. 16, are very satisfactory. (2) A rag, wood, or canvas wheel coated with No. 40 emery. (3) A rag, wood, or canvas wheel coated with No. 120 emery. (4) A rag, wood, or canvas wheel coated with No. 120 emery and finished with an ordinary buff, using buffing compound.

Hot-rolled Rods. (1) A rag, wood, or canvas wheel coated with No. 90 emery. (2) A rag, wood, or canvas wheel coated

TABLE 1. CUTTING LUBRICANTS FOR MONEL METAL

Operation	Lubricant
Boring (fine)	Mineral lard oil, larcul, lard oil and 10 per cent turpentine
Cutting-off	Soluble oils, solul, borax, and aquadag.
General	Mineral lard oil (light), larcul, solul, soluble oils exanol.
Milling	Soluble oils, solul, oakite.

with No. 120 emery. (3) A rag, wood, or canvas wheel coated with No. 120 emery and finished with an ordinary buff, using buffing compound.

Sheets. (1) A rag, wood, or canvas wheel coated with No. 90 emery. (2) A rag, wood, or canvas wheel coated with No. 120 emery. (3) A rag, wood, or canvas wheel coated with No. 120 emery and finished with an ordinary buff, using buffing compound.

The original article also discusses in detail the welding, annealing and pickling of monel metal. (*Mechanical World,* vol. 67, no. 1746, June 18, 1920, pp. 400-401, 3 figs., *p*).

MACHINE SHOP

Tests on the Behavior, Efficiency and Life of Hack Saws

Hack Saws, Their Selection and Use. The ability to cut in the shortest time is one of the important factors determining the value of a hack saw, but the rate at which the saw cuts may be made such as to become destructive. The endurance of the saw is also a factor.

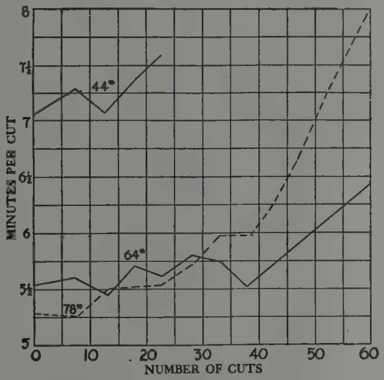


Fig. 9 Effect of Pressure on Time per Cut and Efficiency of Saw

The gradual lowering of efficiency as the saw is used and the effect of successive increases in the pressure are displayed in Fig. 9. The curve for 44 lb. shows how rapidly the saw was running beyond the limit of efficiency, while that for 64 lb. makes clear how the tendency was immediately restrained by the application of more weight. This figure also illustrates the effect of weight or pressure on the rate of cutting and the efficient endurance of the saw, identical blades being used on the same material in this test and different weights employed, the starting weight remaining constant throughout the test in each case.

In the case of the 44-lb. weight, the weight used was below that recommended for the blade employed. The second solid line shows the improvement in performance of a similar saw using the proper weight of 64 lb., while the dotted line illustrates what happens when a slightly excessive pressure is employed. Insufficient weight resulted in an excessive time per cut and on the whole the chart would indicate that, first, it is better to exceed the proper weight a little at the outset than to use too little pressure, and second, no matter how nearly correct the weight is at the outset, after a certain number of cuts have been made the pressure must be increased, not only for the sake of reducing the time per cut to a point within the limits of efficiency, but also to prolong the life of the saw.

The effect of a slight excess in weight on the average time of cuts made before the blade is dulled is clearly shown by the two lower curves in Fig. 9. For the first fifteen cuts the advantage lies clearly with the heavier weight, but from that point on, it is apparent that the first saving in time was made at the expense of the general average for the entire series of cuts.

Another series of tests illustrated by curves in the original article indicates the destructive action of an excessive pressure. While the hack saw must be made to withstand a great amount of abuse, there are limits beyond which it will not go. Where a hack saw is forced to cut at a greatly excessive speed, the gain in time per cut may be offset by loss in saws, spoiled stock, etc. On the other hand, however, insufficient pressure affects the life of the saw almost as rapidly and in the same manner as when too much weight is used. In this case, moreover, the teeth of the blades are destroyed by slipping and sliding over the work rather than by cutting. It would appear, therefore, that using too little pressure is almost as inefficient and costly as using too much, and has not even the doubtful advantage of saving time at the expense of the blade and stock as is the case where too much pressure is employed.

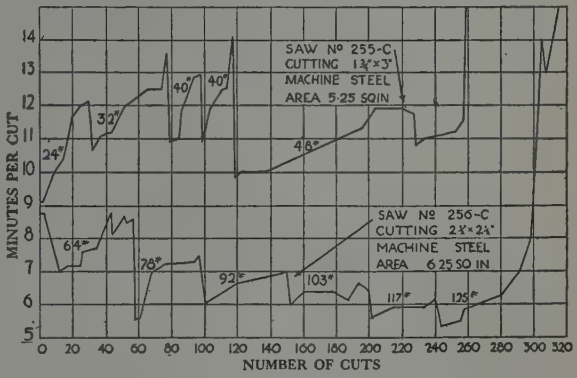


Fig. 10 Effect of Proper and Improper Regulation of Weight on Cutting Speed and Life of Saw

Data are presented on the comparative advantage of flexible and all-hard blades. From this it would appear that the all-hard blades designed for use in machines require less time per cut than flexible blades, while the total number of cuts made by each blade is practically identical and the saws failed in almost the same manner. It would therefore appear that the use of flexible saws in power machines is attended by a loss of time in cutting without any corresponding gain in the life of the blade.

Data are also presented comparing the results of starting with an excessively light weight combined with proper subsequent regulation on one hand, and on the other hand with results obtained by using a slightly excessive weight to start with and then regulating it properly as the number of cuts progresses.

These results are presented graphically in Fig. 10 and from them it would appear that on the first blade (No. 255-C) an excessively light weight was used. The time per cut was excessive until about the thirtieth cut, when the weight was increased with a result in drop in time per cut from 30 min. 35 sec. to 10 min. 35 sec. The blade, however, was dulled so much by sliding over the work that it was not until the weight had been still more increased that the proper time per cut was reached.

In the second test (No. 256-C) a weight of 64 lb. was employed, whereas only 43 lb. is recommended. While overweighted at the start, the blade cut well within the limits of efficiency for nearly 40 cuts.

In presenting the data for these tests, the paper calls attention to the fact that the relative efficiencies of blades can be better determined by the number of square inches cut, rather than merely the number of cuts made. Thus in the above two tests, the first saw cut, before failing, 1365 sq. in. and the second saw 1742 sq. in.

Tests presented graphically in Fig. 11 are of considerable interest as they show the effect of the lubricant. Starrett No. 250 flexible blades were used and all were started under the same pressure of 24 lb. The line *AB* shows the performance of a saw run without lubricant at 65 strokes per min., an excess of 15 strokes over the recommended speed. This saw failed when partly through the fifth cut.

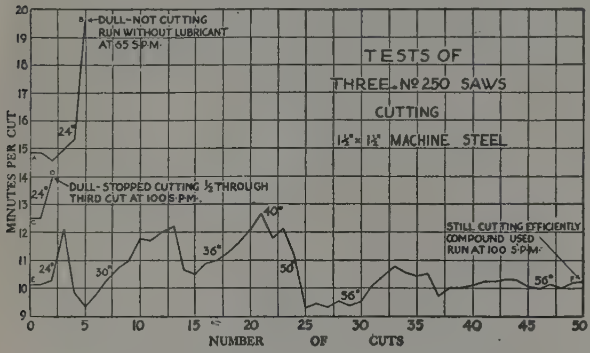


FIG. 11 EFFECT OF USING LUBRICANT ON TIME PER CUT AND ON LIFE OF SAW

The saw of curve *CD* was run dry at 100 strokes per minute, or double the proper speed, and failed very rapidly. The saw *EF* was run with the lubricant compound at 100 strokes per minute, and completed 50 cuts. The test was discontinued before the saw failed.

The following formula is given for making the lubricant compound: To a quart of sal soda thoroughly dissolved in 10 gallons of cold water add 4 quarts of equal parts of mineral and lard oil, and mix thoroughly. The compound is ready for use 10 or 12 hours after it is made.

The original article discusses the question of cost per cut and gives several tables, among others being tables for combined cost per hour for saw, labor and overhead at different costs of labor and saw blades. The question of cornering work is also discussed in detail and various methods of proper and improper cornering are illustrated. (*Canadian Machinery*, vol. 24, no. 4, July 22, 1920, pp. 91-97, 19 figs., *peA*)

MARINE ENGINEERING

British Rivetless Ship

ELECTRICALLY WELDED SHIP "FULLAGAR." Description of the electrically welded, motor-driven ship *Fullagar*.

This ship is a coaster 150 ft. long by 23 ft. 9 in. beam, and 11 ft. 6 in. deep to the main deck. It is an entirely welded ship and there is not a rivet in her from one end to the other. Of course, this may not prove to be absolutely the necessary way of construction, but it was a good way of demonstrating the suitability of electric welding for shipbuilding purposes, although it did not demonstrate that it is necessarily the cheapest way of construction.

The hull is constructed of steel of the usual ship qualities, tested in accordance with Lloyd's rules in the ordinary way.

As a working rule, it was arranged that as far as possible no overhead welding should be called for on the job. Complete elimination of such welding, however, was impossible, but in almost every case it was found that joints could be planned so that such overhead welding as was done should be of a light type and should be reinforced by heavy welds put on in a downward direction.

Illustrations are given of the various types of welds used. Of these, the system of "broken" welding is of particular interest. For joints not required to be watertight, the welding is put on in short lengths with unwelded spaces between instead of being continuous. The only reason for this is economy of labor and material. A sample of such continuous welding is shown at the connections between the main frames and the shell plates in Fig. 12A. Also, in Fig. 12B an arrangement is shown where the welds are placed alternately on either side of the frames.

In the welds shown in Fig. 12C (lower end of the main frames) the frame is welded all around to the plate. Service holes are also shown. These are, of course, employed in connection with erection, but in order to conserve the all-welded construction, they are not riveted after use, but are plugged and welded over.

The whole of the welding has been carried out by the quasi-arc system, previously approved by the Lloyd's Register of Shipping, which latter has also embodied in the ordinary rules of the Society a set of rules for its application.

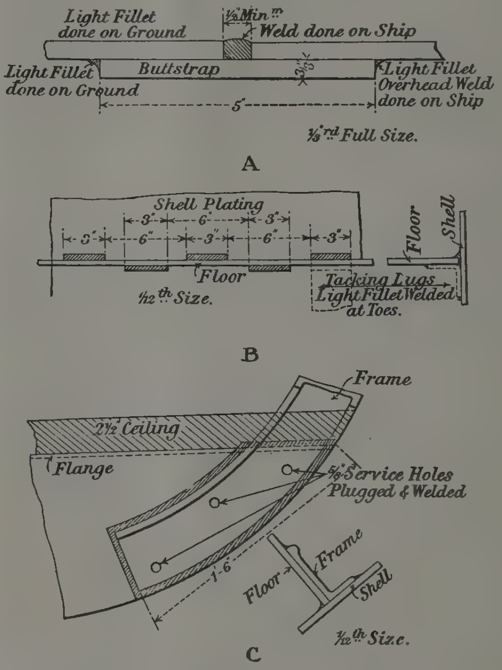


FIG. 12 WELDS USED ON THE ELECTRICALLY DRIVEN SHIP *Fullagar*

The body is fitted with a Cammellaird-Fullagar opposed-piston oil engine of about 540 b.h.p., working on a single screw. (*Engineering*, vol. 110, no. 2844, July 2, 1920, pp. 25-26, 14 figs., *dA*)

MECHANICS

THE STRENGTH OF CARDAN SHAFTS, A Johnson. A mathematical discussion of the forces acting on a Cardan shaft. In this connection attention is called to a paper by Thom in a Swiss engineering magazine abstracted in MECHANICAL ENGINEERING, July 1920, pp. 409-410.

Besides the ordinary twisting moment, a Cardan shaft is subject to a bending moment due primarily to its own weight. It is in the position of a beam supported, but not fixed, at the ends, and uniformly loaded with w pounds per unit length.

The equation which defines the critical length of a shaft as given in reference books is:

$$2l = \pi\left(\frac{gEI}{wa^2}\right)^{\frac{1}{4}} \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where $2l$ = whole length of shaft
g = acceleration due to gravity
E = Young's modulus

I=moment of inertia of section
w=weight of shaft per unit of length, pounds
a = angular velocity of shaft in radians per second.

This formula unfortunately lends itself to ambiguity owing to the selection of incompatible units or careless interpretation of symbols. It is true only when all the dimensions are in *feet*, and consequently when E is Young's modulus in pounds *per square foot*, or 144 times the ordinary tabular value of E in pounds per square inch. Similarly when all four dimensions are taken in inches, the most convenient unit, it is necessary to remember that g is not the abstract number 32.2, but represents a concrete quantity of *feet*, and therefore when 1 in. is the unit the formula for the limiting length of a shaft becomes:

$$2l = \pi \left(\frac{12gEI}{wa^2} \right)^{\frac{1}{4}} \ldots\ldots\ldots\ldots [2]$$

where $2l$ = whole length of shaft, inches
$g = 32.2$
E = Young's modulus in pounds per square inch
I = moments of inertia of section
= $\pi D^4/64$ for a solid round shaft when D = diameter of shaft in inches
w = weight of shaft in pounds per inch length
a = angular velocity of shaft in radians per second.

The author derives the following equation for the greatest bending moment M:

$$\begin{aligned} M &= \beta^2 (Q - 2N)\, EI \\ &= \beta^2 \frac{12g}{2a^2} \left(\frac{1}{\cos\beta l} - \frac{2}{(e^{\beta l} + e^{-\beta l})} \right) EI \ldots\ldots\ldots [11] \end{aligned}$$

where $\beta = \left(\frac{12gEI}{wa^2} \right)^{\frac{1}{4}}$ and Q and N are constants.

Now the bending moment $M = fz$, where f is the greatest stress per square inch of the material, and z is the strength modulus of the section, which for a solid round shaft of diameter D inches is $\pi D^3/32$.

Therefore we have from [11]:

$$f \frac{\pi D^3}{32} = \beta^2 \frac{12g}{2a^2} \left(\frac{1}{\cos\beta l} - \frac{2}{(e^{\beta l} + e^{-\beta l})} \right) E \frac{\pi D^4}{64}$$

or

$$f = DE \frac{\beta^2}{4} \frac{12g}{a^2} \left(\frac{1}{\cos\beta l} - \frac{2}{(e^{\beta l} + e^{-\beta l})} \right) \ldots\ldots [12]$$

where $\beta^2 = \sqrt{\frac{wa^2}{12gEI}}$ as before.

From these equations the author derives Equation [2] by noting that the bending moment and the stress per square inch become infinite when $\cos\beta l = 0$, that is, when $\beta l = \pi/2$.

Thus the author has found that in a shaft of which the limiting length calculated according to Equation [2] was 32 in., a length of 30 in. showed a stress due to bending of only 1400 lb. per sq. in. as calculated from Equation [12], which would indicate that the limiting length of a shaft may be approached closely without danger of stress.

The author believes that if the statements embodied in Equations [11] and [12] have any real physical basis, a shaft need not be in danger at a speed higher than the critical speed if it could be restrained from whirling until the critical speed were well past. (*The Automobile Engineer*, vol. 10, no. 140, July, 1920, pp. 266-267, *tm.*)

MOTOR-CAR ENGINEERING

Frameless Car. Description of a non-conventional design of a car recently patented by the Lancia Company. The body (Fig. 13) consists of a stamped sheet-steel shell and combines the function of a body with that of a frame. At the front of this shell is attached horizontally a form of stirrup, to which in turn is attached a semi-elliptic transverse spring, shackled at each end to the forks of a straight front axle.

Fore-and-aft location of the front axle relative to the body is obtained by the use of a radius rod on each side, running from the bottom of the axle back to the body. Suspension for the rear axle consists of long quarter-elliptic springs, the butt ends of which are attached to the body at a point where a channel rib forming part of the front-seat support crosses and stiffens the body.

An essential feature of this construction is the use of a channel-section rib or tunnel running longitudinally from the front portion to the back and forming also a compartment open at the bottom in which the propeller shaft can move. Clearance for the rear axle is given by a similar tunnel running transversely across the back of the body. These channels may be made by stamping the sheet metal forming the lower portion of the shell to form a longitudinal member, thus improving the stiffness of the body without, to any extent, reducing the footroom capacity of the seating accommodation.

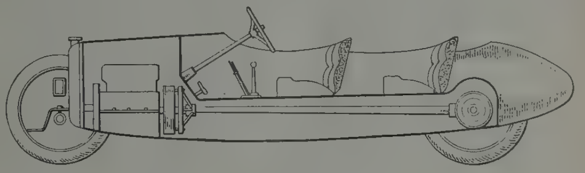


FIG. 13 LANCIA FRAMELESS CAR

No information is given as to how accessibility to the engine is secured in this design. (*Autocar*, vol. 64, no. 1287, June 19, 1920, p. 1160, 2 figs. *d*).

POWER GENERATION

Emmet Mercury Boiler. The basic idea of the Emmet mercury boiler has been known for several years. It is to so use mercury as to increase the temperature range through which the engine operates. Mercury permits it to do so because of its higher boiling point as compared with water. On the other hand, however, if a boiler or turbine were to operate with mercury in the same manner as they are operated today with steam, the amount of mercury needed would be extremely large and there would be considerable danger of leaks, undesirable both because of the high cost of mercury and still more so because of the fact that mercury vapor is poisonous.

To avoid this, Mr. Emmet has designed a binary-vapor plant using mercury vapor and steam. The products of combustion from the furnace pass upward through part of the tubes which form the heating surface of the mercury boiler and then forward through tubes containing water. The mercury tubes are connected to the lower mercury chest and to the mercury header which takes the place of the steam drum in an ordinary boiler. Mercury vapor at about 10 lb. gage pressure is collected in the header and passes to the mercury turbine. Owing to the high density and low velocity of the mercury vapor this turbine may be a single-stage machine of reasonably low speed and may have short buckets. The wheel may be placed inside the mercury condenser for simplicity.

The mercury condenser is a vital part of the unit. It consists of a tank supporting another tank which may be called a steam drum. A number of straight tubes extend from the bottom of the steam drum into the condenser. The exhaust from the mercury turbine is condensed on the surface of these tubes and as the boiling point of the mercury at 28 in. vacuum is 455 deg. fahr., steam is generated inside the tubes. This steam is led to a superheater and finally to the place where it is to be used, while the steam condensate is returned to a condensed-steam receiver and from there through a feedwater heater to the steam boiler.

The mercury condensate is drained from the bottom of the mercury condenser to the lower mercury header and thence to the mercury boiler.

In order to utilize mercury economically and to use a minimum amount of it, a special type of boiler had to be designed. In this boiler flattened tubes are used. Leaks are said to be prevented by great care in the design and construction of the fittings and pipes leading to and from the mercury boiler.

The original article states that Mr. Emmet has claimed that by the addition of this device to an assumed good modern power station with an increase of 15 per cent in the amount of fuel used, the same amount of steam can be supplied to the steam turbine as under present conditions, and the mercury turbine will generate power equal to about 66 per cent of the power generated by the steam turbine.

The experimental equipment was in operation for a short time last summer with a load of over 1000 kw. on the mercury turbine, and its operation showed that the economies predicted were fully realized.

In an editorial article in the August 3 issue of *Power* it is stated that there is a persistent rumor that an Emmet mercury-vapor plant is being built for the Hartford (Conn.) Electric Light Company. This would be of particular interest, as it was in the plant of this company that the first steam turbine of commercial size was installed for electric power generation. (*Power,* vol. 52, no. 5, Aug. 3, 1920, pp. 167-168 and 1 full-page colored diagram, *dA*)

Waste-Heat Boilers, D. S. Jacobus and Arthur D. Pratt, Members Am. Soc. M. E. In modern practice with waste-heat boilers no special effort is made to minimize the frictional resistance of the gases flowing through the boiler by providing a large flow space.

Nowadays, waste-heat boilers are provided having a high draft resistance and in which the baffling is so arranged as to give a relatively small area of flow space through the passes so as greatly to increase the velocity of the gases. On the other hand, a suction fan is used to overcome the higher draft losses due to the increase in velocity of the gases, and the heating surface of the boiler is arranged in series in such a manner that in connection with the added draft loss under the increased velocity, the desired draft will be available at the outlet of the furnace supplying the waste heat as well as the outlet of the boiler.

In waste-heat boilers the heat-transfer rate should be materially higher than in direct-fired boilers. In the latter a temperature is developed greatly in excess of the average waste-gas temperature and a considerable proportion of the total heat absorbed by a boiler is absorbed through direct radiation to the tubes which are exposed to the radiant heat of the furnace.

The absence of this important factor may be compensated in the waste-heat boiler by raising the gas velocity. In this connection it should be borne in mind that the heat-transfer rate is dependent upon the gas velocity and not upon the number of passes, except in so far as the number of passes affects the velocity.

The best arrangement to use in most cases is the three-pass, but the number of passes depends generally on several considerations discussed in detail in the original paper.

Economizers are frequently installed in connection with waste-heat boilers.

The authors recommend a combination in which a three-pass boiler is used. The gases pass from the boiler through the vertical rear circulating tubes directly into an economizer which is made up of horizontally inclined tubes extending transversely to the boiler setting. The gases pass downward over the economizer tubes while the water has an upward flow, the countercurrent being obtained between the water and the gases, and the water in the economizer flowing continuously upward so as to avoid any pockets should steam be formed in the economizer.

Single-pass waste-heat boilers without induced draft were among the earliest to be used and there still appears to be a considerable field for such boilers, even under modern conditions. They can, however, be successfully used only in connection with a furnace requiring a low draft. A single-pass boiler may be used to advantage where a low weight of gas is available and may be best to install in the case of an isolated plant where there is is outlet for the power developed expect for use in the plant. (*Proceedings of the Engineers' Society of Western Pennsylvania,* vol. 36, no. 4, pp. 221-234, and discussion pp. 235-242, *g*)

VARIA

War Experience with Merchant Ships, Prof. J. J. Welch. A paper discussing damage to vessels of various types caused by torpedoes or mines, and suggesting certain changes in design which might make the ship more fit to withstand external explosions.

As regards the nature and extent of damage caused by a torpedo or mine, attention is called to the fact that when a vessel is struck in way of a cargo hold, the hatches are usually blown off, which gives a certain relief of the pressure set up by the explosion. It would appear as probable that large hatchways afford an improved measure of protection to a ship.

The sizes of the holes made by torpedoes varied in the vessels which subsequently reached port from about 40 ft. by 23 ft. to 16 ft. by 14 ft. It would appear that a vessel should be reasonably safe against attack from a single torpedo if it were made capable of remaining afloat with any two holds open to the sea, while the minimum length of hold should not be less than, say, 40 to 45 ft., so as to avoid the possibility of two bulkheads being injured at the same time.

The first effect on a damaged ship was to produce a heel temporarily to the damaged side, due to the influx of water on that side, which heel was eliminated or reduced as the water became uniformly distributed across the ship. In some cases the loss of metacentric height, due to the loose water admitted to holds, was sufficient to render the ship initially unstable, and heeling resulted from this cause; such heeling being diminished, or the ship even regaining the upright, as the water in the hold reached the level of the water outside. This follows from the well-known fact that the loss of initial stability is generally greatest when the quantity of water admitted is relatively small. Treating the question as one of loss of buoyancy, with constant displacement, the position of C. G. of ship remains fixed throughout, while the variation in location of metacenter depends upon the rise of the center of buoyancy and the length of B. M. At an early stage of the inflow, the position of C. B. remains practically unaffected, while the diminution in the length of B. M. is given by $\mu i/V$ with the usual notation, μ being the fractional permeability of the damaged compartment. The value of i, the total amount of inertia of water plane area in damaged compartments, is more or less constant at all heights, and hence the loss of G. M. may be considerable in the early stages, and less important as the water rises in the compartment and so raises the position of the center of buoyancy of ship. For this reason it is more important to have watertight doors low down in the containing bulkheads of damaged compartment shut at the time of the casualty than similar doors at a higher level. The final result may be the same, but by confirming the longitudinal extent of the free water low down, the ship may continue upright, and if the ship has ultimately to be abandoned, the upright position will facilitate the getting away of the boats and so conduce to the saving of life.

An examination of the steamers torpedoed showed that very few capsized, but a fairly large number retained a list after damage. Some of these ships listed in a lightly laden condition, due to the fact that many vessels of relatively fine form have only very moderate matecentric heights when lightly laden, so that the loss of stability due to the inflow of water might have been sufficient to give a negative G. M. with consequent heeling; in one case, indeed, the loss of stability due to this cause was so great as to result in the capsizing of the vessel. On the other hand, vessels in full form carrying their breadth well down often have very large matacentric heights when lightly laden and many such vessels in this condition have continued afloat upright with two or more large compartments flooded. (Paper read before the Institution of Naval Architects, July 6, 1920, abstracted through *Engineering,* vol. 110, no. 2845, July 9, 1920, pp. 37-40, 2 figs., *dg*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

United States Forest Products Laboratory Celebrates Its Decennial

EXTENSIVE conservation of our national wealth of wood through more efficient utilization was the keynote sounded throughout the Decennial Celebration at the Forest Products Laboratory at Madison, Wis., July 22 and 23. Over 200 visitors from all parts of the country were present, representing every line of wood-using industry, including 59 wood-using associations and companies, 18 lumber-manufacturing associations and companies, the deans of 12 forestry schools, the United States Forest Service, and other visitors and friends. They came to pay tribute to the laboratory's ten-year record of service to American industry.

The Forest Products Laboratory is a government institution of industrial research in wood and all wood products maintained by the United States Forest Service in coöperation with the University of Wisconsin. In this work 220 engineers, wood technologists, manufacturing specialists, and assistants are employed in developing new uses for wood and improving present manufacturing methods. Investigations and experiments are undertaken both independently and for individuals and companies on a coöperative basis.

The committee in charge of the celebration consisted of Governor Philipp of Wisconsin, honorary chairman; H. F. Weiss, Burgess Laboratories, Madison, and former director of the laboratory, chairman; C. P. Winslow, director, Forests Products Laboratory; H. J. Thorkelson, business manager, University of Wisconsin, and Don E. Mowry, general secretary, Madison Association of Commerce.

The opening session of all the celebration convened at ten o'clock on the morning of July 22. The program of addresses included Legislative Measures for Forest Conservation, by Governor Philipp; Translating Knowledge into Power, by President Birge of the University of Wisconsin; and The Forest Products Laboratory, by C. P. Winslow, present director of that institution.

After luncheon the program continued with inspection of the work and exhibits of the laboratory. Guides in charge of small parties showed the visitors the various lines of endeavor in which the laboratory is saving millions of dollars a year to the people of the country.

Nearly 500 prominent lumbermen, manufacturers, and users of forest products, and members of the Forest Products Laboratory, attended the banquet in the evening, at which Lieut-Col. W. B. Greeley, Chief Forester of the United States, spoke on Forests and National Prosperity; and Mr. Max Mason, research specialist of the National Council of Defense, gave an illustrated talk explaining in detail the submarine detector which he perfected during the war and which was successfully used in European waters.

At the Friday morning session D. C. Everest, secretary and general manager, Marathon Paper Mills Company, spoke on Some Problems of the Pulp and Paper Industry; H. E. Howe, chairman, Research Extension Division, National Research Council, on America's Place in Industrial Research; and W. A. Gilchrist, representing the National Lumber Manufacturers' Association, on Some Problems of the Lumber Industry.

In the Forest Products Laboratory the Government has established an institution which is doing much direct good for all of the wood-using industries. Director Winslow in speaking of its purposes and work illustrated the manifold uses of wood in connection with the every-day life of the people. He brought out the great problems of conservation and utilization of forests, of cut lumber and of finished product. He stated that it was the broad purpose of the Forest Products Laboratory to aid the nation in solving these problems.

Mr. Winslow gave statistics showing by conservative estimate that the work of the Forest Products Laboratory effected an annual increase in production and decrease in waste aggregating $30,000,000. These figures, he said, should prove the value and importance of industrial research.

THE ST. LAWRENCE RIVER PROJECT

(*Continued from page* 512)

It would seem, therefore, that the minimum power that may be developed from the St. Lawrence and distributed through northern New York and northern New England would be about 830,000 hp. It is not unlikely, however, that in the final bargaining between the two countries regarding the whole matter the United States may assume some of the expense of the improvement below the international section of the river and in return receive more power, inasmuch as the demand is relatively greater in the United States.

In a preliminary way the Canadian Government recently estimated the cost of the St. Lawrence improvement for the international section (including preparation for power installation but not the machinery and equipment for power development and distribution) at $60,000,000 and for the all-Canadian section of the river $50,000,000, not to include power development. The total, $110,000,000, may upon more detailed examination prove to be too small and $200,000,000 may be necessary. Suppose that the United States pays one-half of the total, $100,000,000, and gets one-half of the 4,000,000 hp. No matter how low the rental price on this may be, great profits should be derived and in a few years the entire cost amortized. Then there is the more fundamental question of conservation. A horsepower-year has been reckoned as equivalent to a coal saving as high as 30 tons; however, the author considers this too much and assumes 20 tons instead. The total coal to be saved is a very important item, and if 40 million tons of fuel can be saved, the additional tonnage necessary to transport it from the coal fields to the territory where the electric power would be used will be saved with it. This element of saving is variously reckoned at from 10 to 25 per cent of the primary coal tonnage. Considered internationally the saving would be predicated on the full 4,000,000 hp. and might amount to 100 million tons a year.

Again, there is the question of man power. How many miners are required to mine 100 million tons of coal, and how many mine laborers and others are employed in and about the mines? How many railway employees would be necessary to transport the coal and to haul the empty cars back to the mines? How many firemen and engineers in steam-driven power plants would be saved for other productive effort? The problem has many ramifications, but from whatever angle it is considered, a possibility of saving is at once apparent. The improvement of the St. Lawrence river is amply justified, even if considered solely as a conservation measure. Indeed, a careful study of the problem will show that there is no excuse for the people to neglect the taking of adequate steps to develop this power.

Returning to the question of transportation, if the United States is to continue shipping abroad yearly 300 million bushels of grain produced in the Middle West, how much of the shipping cost can be saved? Mr. Julius Barnes, who has just been relieved of his duties as Chief of the U. S. Grain Corporation, states that it may safely be estimated at from 5 to 6 cents per bushel, which would be $15,000,000 to $18,000,000 per annum. There are also other goods to be shipped in and out. That the total saving would be enormous and sufficient to justify the expense is undoubted.

Consider also the effect on immigration. At the present time the United States and Canada are suffering from a lack of man power. At the present time immigrants, particularly from the northern countries—Holland, the Scandinavian countries, and the British Isles—are very desirable. The cost of coming to our shores is now several times what it used to be, and when they land at some Atlantic port they must either stay in the already congested areas there or pay a big charge for railroad transportation. Some of the northwestern states have a large percentage of Scandinavian-born people. Practically all of the Scandinavians who come to this country settle in Wisconsin, Minnesota, and the Dakotas. Others will no doubt do the same. If they could come directly to some one of our Great Lakes ports, consider how much easier it would be for them and how much less expensive, not to mention the benefits of such immigration to the Central West.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Engineering Experiment Station, Iowa State College

THE Engineering Experiment Station of the Iowa State College was established in 1904 and since that time it has issued 57 bulletins. Twenty-one of these have been devoted to sewage, drainage, drainage tiles and sewer pipes, nine to bricks and roads, nine to the use of Iowa coal for power and house heating and to mechanical-engineering subjects. In addition to these there have been bulletins on the holding power of nails, cement, concrete, electric power on the farm, topographical surveys, lighting, structural work and paints. For further information address Dean Anson Marston, Director, Engineering Experiment Station, Ames, Iowa.

Coöperation

The Portland Cement Association and the Lewis Institute of Chicago are coöperating in their structural materials research laboratory. A number of bulletins have been issued as a result of this work. The Advisory Committee from Lewis Institute includes Profs. Duff A. Abrams and Philip B. Woodworth, while the Portland Cement Association is represented by Chairman F. W. Kelley of Albany, N. Y., and Ernest Ashton, of Allentown. Pa.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Cement and Other Building Materials A5-20 Modulus of Elasticity of Concrete. Bulletin No. 5 of the Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill., by Stanton Walker, is on modulus of elasticity of concrete, with an appendix applying the results obtained to flexure of reinforced-concrete beams. Results show that the stress-deformation curve is of the form $S = Kd^n$ and the modulus of elasticity varies with the stress in a manner represented by the equation $E = CS^m$, where $S =$ unit stress, $d =$ unit deformation and $E =$ modulus of elasticity.

There is no true elastic limit since the stress-deformation diagram is a curved line. There is a point where the equation above for stress and deformation no longer holds and this corresponds to the yield point used by some writers. This occurs at from 50 to 90 per cent. of the ultimate strength.

Four moduli of elasticity are noted: The initial tangent called E_i; the tangent modulus at from 5 to 50 per cent of the compressive strength called E_t; the secant modulus from 5 to 50 per cent of the compressive sthength E_s; and the cord modulus E_d, which is determined by taking points on each side of the point at which the tangent modulus is found. The tangent modulus and the cord modulus are approximately the same. The initial modulus is given by the equation $E_i = 33{,}000\, S^m$, where $m = 0.625$. The modulus at 25 per cent of the compressive strength is given by $E_{t25} = 66{,}000\, S^m$, where $m = 0.5$. The modulus of elasticity and strength increases as the aggregate becomes coarser, as the quantity of cement in the batch increases, as the age of the concrete increases and as the time of the mixing increases. The quantity of water has a great effect on the modulus and the strength. These decrease as the water is increased. There is no marked difference between concretes made of high-grade pebbles, crushed limestone, crushed granite or blast-furnace slag. Address Prof. Duff A. Abrams, Lewis Institute, Chicago, Ill.

Cement and Other Building Materials A6-20 Effect of Fineness of Cement. The effect of fineness of cement is discussed by Professor Duff A. Abrams in Bulletin No. 4 of the Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill. The bulletin contains 81 pages and is the result of tests on 6125 concrete cylinders, 4935 cement-mortar cylinders and 4065 briquets, as well as over 5000 other tests. Some of the conclusions reached are as follows:

1. There is no necessary relation between the strength of concrete and fineness of cements if different cements are considered.
2. In general the strength of concrete increases with the fineness.
4. Fine grinding of cement is more effective in increasing the strength of lean mixtures than rich ones.
5. Fine grinding is more effective on short-time tests.
12. The fineness of cement has no appreciable effect on the yield or density of concrete.
14. The unit weight of cement decreases with fineness.
23. Tension tests of briquets do not give a correct measure of the relative merits of different cements as determined by compression tests of mortar and concrete.

Address Prof. Duff A. Abrams, Lewis Institute, Chicago, Ill.

Cement and Other Building Materials A7-20 Storage of Cement. Bulletin No. 6 of the Structural Materials Laboratory of Lewis Institute, Chicago, Ill., on the Effect of Storage of Cement, by Prof. Duff A. Abrams, was issued in June. The report includes compression tests on about 1000 6-in. by 12-in. concrete cylinders and 1000 2-in. by 4-in. cylinders of 1:3 standard sand mortars and about 500 miscellaneous tests. Tests have been under way for 3½ years. The following conclusions are noted:

1. Indications of the 1:5 concrete cylinders and 1:3 Ottawa sand-mortar cylinders are comparable.
2. Compression tests showed a deterioration in strength with storage of cement for all samples. The deterioration was greatest in the samples stored in open shed in yard, sample stored in basement of building showed less deterioration and those in laboratory showed still less.
3. After three months' storage in shed in yard cement had 80 per cent. of its original strength; after six months, 71 per cent.; after one year 61 per cent, and after two years 40 per cent. The deterioration was probably greater in these tests on from 8 to 12 sacks than it would be found in a larger amount of cement stored under similar conditions.
5. For periods up to 1½ years there is no marked difference in the quality of cement stored in cloth and paper bags.
6. Only a slight advantage was found from protection of cement in cloth sacks which were covered by a thin layer of portland cement or hydrated lime.
8. Storage of cement prolongs the time of initial and final setting.
10. The normal consistency was slightly effected by storage.
12. The deterioration of cement in storage appears to be due to absorption of atmospheric moisture causing partial hydration which exhibits itself in reducing the strength of the concrete and prolonging the time of setting.

Address Prof. Duff A. Abrams, Lewis Institute, Chicago, Ill.

Cement and Other Building Materials A8-20 Strength of Drain Tiles. Bulletin No. 57 of the Engineering Experiment Station of Iowa State College, on supporting strength of drain title and sewer pipe under different pipe-laying conditions, by W. H. Schlick, was issued in April 1920. The bulletin contains 68 pages divided into six sections as follows:

1. The problem of design of drains and pipe sewers with safe supporting strengths.
2. General description of investigation.
3. Earth and pipe-laying methods.
4. Concrete-cradle pipe-laying methods for firm soils.
5. Concrete-cradle pipe-laying methods for yielding soils.
6. Pipe-laying methods with concrete cradles whose values are independent of the nature of the soil.

Tests were made on 24-in. sewer pipes, 24-in. clay drain pipes, 18-in. sewer pipes and drain pipe and 12-in. sewer pipe. The tests for the ordinary earth beddings showed the ordinary supporting strength of pipes to be slightly exceeded, while special laboratory tests showed that the effect of eliminating hub holes in trenches decreased the strength of the pipe from 15 to 27 per cent. With concrete beddings the strength of the pipe was increased from 70 to 100 per cent. in firm soils and from 32 to 68 per cent. in yielding soils. In general the concrete bedding will increase the strength of the tile about 100 per cent.

Address Engineering Experiment Station Ames, Iowa, Anson Marston, Director.

Cement and Other Building Materials A9-20 Concrete and Cement. The bulletins issued by the Structural Materials Research Laboratory of the Lewis Institute carried out through the coöperation of the Lewis Institute and the Portland Cement Association are as follows:

Circular 1	Colorimetric Test for Organic Impurities in Sands, by Duff A. Abrams and Oscar E. Harder (1917). Out of print.
Bulletin 1	Design of Concrete Mixtures, by Duff A. Abrams (1919).
Bulletin 2	Effect of Curing Condition on the Wear and Strength of Concrete, by Duff A. Abrams (1919).
Bulletin 3	Effect of Vibration, Jigging and Pressure on Fresh Concrete, by Duff A. Abrams (1919).
Bulletin 4	Effect of Fineness of Cement, by Duff A. Abrams (1919).
Bulletin 5	Modulus of Elasticity of Concrete, by Stanton Walker (1920).
Bulletin 6	Effect of Storage of Cement, by Duff A. Abrams (1920).

Address Prof. Duff A. Abrams, Lewis Institute, Chicago, Ill.

Fuels, Gas, Tar and Coke A8-20 Heating Values. The heating value of a gas containing sufficient hydrocarbons to burn yellow may be obtained by burning the gas in a burner so constructed that the gas and air thoroughly mix and determining the relative amount of air to gas at the instant at which the yellow tip disappears. From a great number of experiments at different pressures and with gas of different heating values it was found that the air-gas ratio was always the same at the instant at which the yellow tip disappeared. The fact that the amount required for complete combustion should be a measure of the heating value has been known for some time. These experiments, however, were conducted to prove the fact and to develop a simple form of burner and apparatus by which the mixture of air and gas could be readily determined at the disappearance of the yellow tip. The mixture is expelled by rising water from an apparatus which gives a constantly changing air-gas ratio and then water. The water is stopped when the flame passes through the yellow tip and the stationary level is a measure of the heating value of the gas. The laboratory has devised the formula B.t.u. $= 158R + 276.5$, where R is the value of the air-gas ratio and the heating value is the heating value of 1 cu. ft. The slope of the line (158) is approximately equal to the gram molecular heat of combustion of the radical CH_2. The constant of the equation 276.5 is the heating value per cu. ft. of C_2 burned to CO_2 on the assumption that C_2 is a gas.

Address Edward J. Brady, Physical Laboratory United Gas Improvement Company, 3101 Passayunk Ave., Philadelphia, Pa.

Metallurgy and Metallography A12-20 Arsenic in Steel. The effect of arsenic in steel has been determined at the naval gun factory by P. E. McKinney, chemist and metallurgist.

"In view of the fact that the question has frequently arisen as to the effect of varying percentage of arsenic in steel," says Mr. McKinney, "it was deemed expedient to make a few experiments in connection with the regular manufacturing operation on the effect of this element.

"Two series of experiments were made, the first consisting of a comparison between a plain converter steel and steel from the same heat to which had been added 0.1 per cent arsenic. The second series was identical except that an addition of 0.5 per cent arsenic was made.

"After adding the final addition to a regular converter heat, a 3¾-in. diam. by 32-in. long split ingot mold was top-poured from a bull ladle for this plain test. Then about 3 in. of steel was poured into a hot bull ladle, of about 100 lb. capacity, to cover bottom, the metallic arsenic mixed with several times its weight of thermit and wrapped in paper, was thrown in ladle, the ladle was then filled with steel, mixed and top-poured into a similar mold. This constituted the arsenic test ingot. Both series were handled in the same way.

"The ingots were stripped the following morning, sent to forge shop, heated and forged longitudinally from bottom end to ¾-in. square, and cut into 6-in. lengths—a convenient size for test bars. They were not soaked or annealed before forging but both series worked excellently while being forged. All of the 6-in. lengths were annealed at 1400 deg. fahr., and then heat-treated as shown in Table 1. The ingots whose heat numbers are followed by the letter A are those to which arsenic was added:

TABLE 1. EFFECT OF VARYING THE PERCENTAGE OF ARSENIC IN STEEL

FIRST SERIES

	Heat No.	C	Si	P	S	Mn	As	Remarks
Chemical analysis	C-1082	0.18	0.26	0.025	0.021	0.60	0.031	No arsenic added
	C-1082A	0.10	0.24	0.023	0,030	0.62	0.089	1% arsenic added

Annealed	Oil-quenched	Drawn								
deg. fahr.			Heat No.	P. E. L.	T. S.	Elong. %	Red. %	Rupture	Bend.	Fracture
1400	....	....	C-1082	48300	75300	32.50	62.30	138900	....	Perfect cup
1400	....	....	C-1082A	43200	72200	33.50	62.79	125520	....	½ cup
1400	1450	500	C-1082	48400	92900	26.00	57.22	162100	180°	$\frac{8}{10}$ cup
1400	1450	500	C-1082A	53500	88100	28.50	60.56	164800	180°	Perfect cup
1400	1450	1000	C-1082	58600	88400	28.25	60.56	157800	....	¾ cup
1400	1450	1000	C-1082A	53400	85300	31.25	64.42	179200	....	$\frac{3}{5}$ cup
1400	1450	1200	C-1082	53500	84500	32.25	65.43	161100	....	$\frac{95}{100}$ cup
1400	1450	1200	C-1082A	53500	80000	32.00	67.74	162500	....	¾ cup

SECOND SERIES

	Heat No.	C	Si	P	S	Mn	As.	Remarks
Chemical analysis	C-1123	0.13	0.25	0.019	0.048	0.57	0.065	No arsenic added
	C-1123A	0.12	0.33	0.018	0.045	0.57	0.310	0.5% arsenic added cold

Annealed	Oil-quenched	Drawn								
deg. fahr.			Heat No.	P. E. L.	T. S.	Elong. %	Red. %	Rupture	Bend	Fracture
1400	....	....	C-1123	35500	67700	32.00	68.00	147300	....	¾ cup
1400	....	....	C-1123A	39600	67800	31.50	67.50	139000	....	½ cup
1400	1450	500	C-1123	45800	75100	31.00	62.20	143800	180°	$\frac{3}{5}$ cup
1400	1450	500	C-1123A	45800	77600	25.00	58.50	141300	180°	½ cup
1400	1450	1000	C-1123	45800	72100	30.15	65.40	141500	....	$\frac{3}{5}$ cup
1400	1450	1000	C-1123A	49600	74000	33.50	64.60	143700	....	$\frac{3}{5}$ cup
1400	1450	1200	C-1123	42700	69300	32.00	70.40	157300	....	$\frac{3}{5}$ cup
1400	1450	1200	C-1123A	48800	73400	33.50	69.50	153600	....	¾ cup

"The results of these tests show practically no difference between the steel containing no arsenic and that to which arsenic has been added, and if anything the result of test shows slight superiority in favor of the steel containing arsenic. While these tests were made on small ingots and the test piece received considerable longitudinal forging work, the results of these preliminary tests would not indicate that arsenic has the detrimental effect to steel attributed to it by some authorities.

"There is no noticeable difference in the properties of steel containing arsenic as compared with that to which no arsenic additions were made. In the pouring or forging the steel acted normal in every respect."

While it is evident from these experiments that 0.3 per cent of arsenic is not injurious, as far as static testing can disclose, the fact must not be lost sight of that it is extremely hard to get rid of arsenic after it is once present in steel, and if the steel is used for scrap purposes after its usefulness has ceased, there is a constant automatic augmentation of the arsenic content which will in time get beyond the limits desired. It would also be interesting to note the effect of arsenic upon shock-resisting qualities of the steel which is of major importance where ordnance work is concerned.

The Gun Factory hopes to have an impact machine installed in the very near future, and further experiments along this line will be carried out.

Address Bureau of Ordnance, U. S. Navy, Washington, D. C.

Metallurgy and Metallography A13-20 Tests for Defects in Spring Steel. Numerous breakages were obtained in ¾-in. round silico-manganese spring steel during a 24-hr. solid clamping test of spring steel. Deep seams were found in torsion tests. After various heat treatments seams developed. To guard against the receipt of such bars a comparison test has been devised in which a piece, the length of which is 1½ times the thickness of the bar, is compressed to a length equal to the thickness of the bar. Internal seams open widely under such a test. Metallurgical and Testing Division, Naval Gun Factory, Washington, D. C. Address Chief of Bureau.

Metallurgy and Metallography A14-20 Alloy Steels. An investigation including an extensive micrographic examination of specimens indicates that zirconium, titanium and aluminum are not truly alloying elements but act merely as scavengers. When not eliminated in slag they are present in the steel as inclusions. In small amounts they may help produce soundness but otherwise they can not do much good and may even be detrimental. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—RESEARCH IN PROGRESS.

The purpose of this section of Engineering Research is to bring together those who are working on the same problems for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Metallurgy and Metallography B8-20 Bearing Metal. Compressive tests at 25, 50, 75 and 100 deg. cent. have been made on five different compositions of babbitt metal, four of which correspond to proposed specifications of the S. A. E. The best pouring temperature and the effect of aging as well as the micromechanism of failure will be investigated. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Textile Manufacture and Clothing B2-20 Cotton Research Company. The work of the Cotton Research Company is divided between researches in the mill and in the laboratory. The mill researches are as follows:

Relative value of speeds of heaters and blows per inch in picking processes;
The best speed for doffers and drafts to use in carding different cottons;
Comparisons of yarns made from various varieties of cotton with and without combing process;
Comparison of spinning with self-weighted and lever-weighted rolls;
Size mixtures most suitable for various types of warp yarns;
Connection between atmospheric conditions and relative weights throughout manufacture of yarns.

The laboratory researches are devoted to the following:

Analysis of cotton fibers and raw cotton throughout manufacture;
Value of fabrics from yarns containing various amounts of twists per inch;
Effects of humidity on sizing and breaking of fabrics.

Address Cotton Research Company, 1020 Washington St., Boston, Mass. E. D. Walen, Manager.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire cooperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring cooperation or aid will state problems for publication in this section.

Internal-Combustion Motors C1-20 International Harvester Co. The problems covered by Laboratory No. 5 of the International Harvester Company devoted to gas-power engineering is concerned with two sets of problems:

A Development of present manufactured products.
B Development for future market.

Under A there are two main divisions:

I Materials of Construction.
II Working Processes.

Under Materials of Construction the following sub-division occurs:

1 Characteristics of present products
2 Changes to eliminate failure in service
3 Changes for improvement in operation
4 Changes to facilitate production or manufacture
5 Development to meet future conditions.

Under Working Processes the following subdivisions are found:

1 Determining the performance, characteristics and laws of the present working process.
2 Changes to meet present difficulties or failures in service.
3 Development to secure improved operation, production or economy.
4 Development to meet future conditions.

Machine Design C1-20 Ball Bearings. Recent investigations on the arrangement, strength and serviceable features of ball bearings for flat footstep bearings is desired by W. S. Aldrich, American Bridge Company, Gary, Ind.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work can be done.

International Harvester Company D1-20 Gas-Power Engineering Laboratory. Laboratory for the development of research work on trucks, tractors, stationary engines of high and low compression, lighting outfits, various accessories and other products. Road tests are also operated by the Company.

The laboratory is situated in a building with a sawtooth roof, equipped with traveling crane, piping for water, gasoline, kerosene and compressed air and wired for electric power. Fuel is supplied to engines from individual tanks on scales. Exhaust is cared for by overhead exhaust line connected to fan blower. Ventilator stacks with openings at floor level are equipped with an exhaust fan. A motor-generator set supplies direct current for battery charging, field and armature current for d.c. motors and generators and field current for the Sprague dynamometer.

Equipment

100-hp., 1050 to 3500 r.p.m. Sprague dynamometer fitted with electric contactors for fuel weighing and recording revolutions.
Electrically indicating tachometer.
Electrically controlled revolution counter.
Hand tachometers.
Revolution counters and stop watches.
Toledo scales, electrically controlled for time element and hydrometers are used in fuel measurement.
Venturi meters recording water meters, sharp-edged orifices and pressure gages are used for water measurement.
Bristol recording thermometers, nitrogen-filled mercury thermometers.
Leeds & Northrup recording and indicating potientiometer.
Hoskins pyrometer and thermocouples are used for heat measurement.
Crosby indicators, diaphram indicators of the Bureau of Standards and manograph are used for power measurement.
An air-equalizing tank with sharp-edged orifice and Ellison gage.
Venturi tubes, pitot tubes and anamometers, displacement gas meters, recording and indicating barometers.
Thermometers and psychometers are used for air measurement.
Five test stands with direct-current generators are used for absorbing power.
Five stands with prony brakes are used for testing engines. Three of these are equipped with balances and supported brakes. Several other test stands are used for small and large engine work.

A brake band testing outfit is arranged to measure belt tension, slippage and durability as well as the coefficient of friction and endurance of brake and clutch linings. An apparatus for determining the endurance of fan belts under various tensions and temperatures is installed in this section of the laboratory.

The friction losses in gear-transmission lubricants are determined by a motor driving a generator through gear transmission.

The laboratory is planning apparatus to determine the tractor drawbar pull, tractive effort, torque reaction about driving axle, power delivered by belt pulley and general performance data from tractors.

The laboratory is equipped to determine the heat dissipation of radiators at various rates of air and water flow.

The laboratory is equipped for the development work on high-compression engines. A 1-hp. Hvid thermoil engine and a 10-hp. high-compression engine are installed.

The capacity, endurance and performance characteristics of generators and storage batteries or other electrical apparatus may be determined by the equipment in the laboratory. Apparatus for determining the characteristics of steam and steam engines are found in the laboratory.

Calorimeters for determining the heating values of solid and liquid fuels are found in the Chemical-Physical laboratory of the Company.

The laboratory is equipped for complete and thorough investigations of automotive apparatus, the characteristics of engine auxiliaries and development work on specific problems.

Research Personnel:

Chief Engineer, Steam Research Engineer, several development engineers and office force of computers, a test-force foreman, chief tester, testers and mechanics.

Address International Harvester Company, 606 South Michigan Ave., Chicago, Ill. E. A. Johnston, Manager, Experimental Department.

E—RESEARCH PERSONNEL

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession and especially the members of the A. S. M. E., of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. After these bibliographies are prepared they are loaned to the person requesting them for a period of one month. Additional copies are prepared which are available for periods of two weeks to members of the A. S. M. E. or to others recommended by members of the A. S. M. E. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society which is probably the largest Engineering Library in this country.

Mechanics F1-20 Impact and Alternating Stress Tests. Impact. A bibliography of 10 pages. Address A. S. M. E., 29 West 39th St., New York.

Molecular Physics F1-20 Capillarity and Surface Tension. A bibliography of 1 page. Address A. S. M. E., 20 West 39th St., New York.

Properties of Engineering Materials F1-20 Impact and Alternating Stress Tests. Impact. A bibliography of 10 pages. Address A. S. M. E., 29 West 39th St., New York.

WORK OF THE A. S. M. E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 269 and 307 to 312 inclusive, as formulated at the meeting of June 24, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE No. 269 (Reopened)

Inquiry: If, under the provision made in Par. 212 of the Boiler Code, advantage is taken of the opportunity to increase the pitch of the staying for a cylindrical furnace, is it to be assumed that a portion of the increased load on the staybolt is to be supported by the resistance of the outer cylindrical shell to collapse, or must the staybolt be designed to carry the full load upon the stayed area of the furnace sheet?

Reply: The special provision made in Par. 212c for increased pitch is made possible by the additional strength afforded by the convexing of the plate. It is permissible under this rule to increase the spacing of the staybolts to p_1 in the formula, whereas the required cross-sectional area of the staybolts should be based on p.

CASE No. 307

Inquiry: Is it permissible to so locate the supporting lugs on h. r. t. boilers where more than four lugs are required and under Par. 323 of the Code, must be set in pairs, that those in each pair come close together, or must the horizontal distance between the center lines of rivets attaching the adjacent lugs to the shell be at least equal to the vertical spacing of rivets that is required for lug attachments in Par. 323, as shown in Fig. 8?

Reply: There is no requirement in the Code specifying the distance apart of the lugs forming pairs as required by the last sentence of Par. 323. It is the opinion of the Committee, however, that in locating lugs in pairs on the shells of h. r. t. boilers, it will be in conformity with the spirit of the second sentence of Par. 323 if the lugs of the pair are so spaced that the horizontal distance between the centers of the rivets which come nearest the adjacent edges of the lugs is at least 6 in., and not more than 12 in.

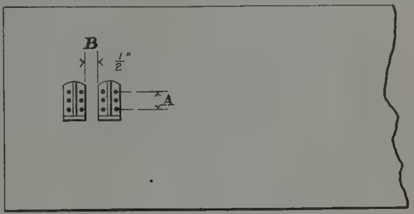


FIG. 8 SPACING OF SUPPORTING LUGS IN PAIRS ON H. R. T. BOILERS

CASE No. 308

Inquiry: Under what rules in the Boiler Code should the top head of a vertical submerged-tube type of fire-tube boiler, such as shown in Fig. 9, be calculated to determine whether or not it requires bracing?

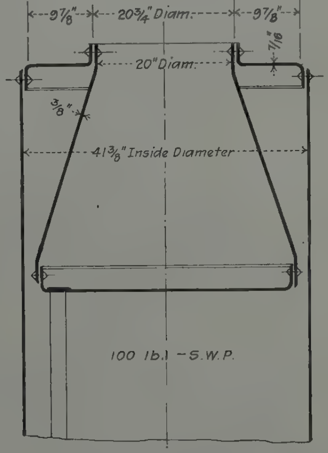


FIG. 9 DESIGN OF TOP HEAD OF VERTICAL SUBMERGED-TUBE TYPE OF FIRE-TUBE BOILER

Reply: There is no rule in the Code specifically applying to such construction. However, in Par. 216, an allowance is made for surfaces located between tubes and shells. It is the opinion of the Committee that it would be entirely safe to permit similar allowances in this case, that is, the distance between supported points could be made 3 in. greater than the permissible spacing of staybolts for the corresponding plate thickness and pressure given in Table 4.

Case No. 309

Inquiry: Is it necessary to furnish test reports of the steel used in the tubes or flues of special type boilers which are formed of 18 in. lap welded steel tubing, 15 ft. long, where the wall thickness is ½ in. and the weld meets the requirements of Par. 186?

Reply: It is the opinion of the Committee that the material used in the manufacture of lap-welded low-carbon steel tubing should meet the stipulations prescribed in Pars. 23 to 39 inclusive of the Code, which will make it necessary to furnish mill test reports of the material.

Case No. 310

(In the hands of the Committee)

Case No. 311

Inquiry: Is it necessary under Par. 188 of the Boiler Code to use butt-stray joints in the construction of very small drums, say, 10 or 12 in. in diameter, for pressures exceeding 100 lb. per sq. in? Such construction does not appear to be practical for such small drums and neck pieces sometimes used to connect drums or shells.

Reply: Lap-riveted construction is prohibited by the Code Rules, but it is the opinion of the Committee that this should cause no hardship as lap-welded or seamless pipe or tubes could be used, provided such tubes or pipes are constructed from material which in its initial form of plate or skelp conforms to one or the other of the specifications for open hearth steel given in the Boiler Code. No test would be required on the completed tube. (See Case No. 255).

Case No. 312

Inquiry: Is it necessary in the construction of small Star-type water-tube boilers for steam heating which are to carry more than 15 lb. pressure at times, to drill the inside and outside ends of staybolts? It is believed that it was the intent of the Committee to cover in this requirement the water legs at front and back ends which are considered as headers.

Reply: If the grate area is more than 15 sq. ft., the staybolts are less than 8 in. in length, and the pressure exceeds 15 lb., it will be necessary to drill the staybolts in order to comply with the Code requirements.

Conference Committee on Welding

The Boiler Code Committee takes pleasure in announcing that the American Welding Society has appointed a Committee to confer with the Sub-Committee of the Boiler Code Committee on Welding. The above is the result of an invitation extended by the Council of the A.S.M.E. at the request of the Boiler Code Committee. It is the desire of the Boiler Code Committee that the Committee of the American Welding Society shall coöperate with the Sub-Committee of the Boiler Code Committee in discussing the rules now in the Code and in proposing any revisions or new rules that may be embodied in the Code at the next revision period. The personnel of the Committee appointed by the American Welding Society is as follows:

A. S. Kinsey, *Chairman*, Stevens Institute of Technology, Hoboken, N. J.

C. A. Adams, National Research Council and Director of American Bureau of Welding, 29 West 39th St., New York, N. Y.

A. M. Candy, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Alexander Churchward, Wilson Welder & Metals Co., 253 36th St., Brooklyn, N. Y.

J. H. Deppeler, Metal & Thermit Corporation, 92 Bishop St., Jersey City, N. J.

R. E. Kinkead, Lincoln Electric Co., Cleveland, Ohio.

Victor Mauck, John Wood Mfg. Co., Conshohocken, Pa.

Stuart Plumley, Davis-Bournonville Co., Jersey City, N. J.

H. S. Smith, Prest-O-Lite Company, 30 East 42nd St., New York, N. Y.

R. E. Wagner, General Electric Co., Pittsburgh, Pa.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A. S. M. E. affairs.

Federation an Opportunity for Local Societies

To the Editor:

The engineering profession of the country has been groping for many years after a suitable means of impressing its personality upon the public quite aside from the effort to secure betterment of individual conditions which has led to the remarkable development of the American Association of Engineers. The means sought for is at last at hand in the organization created on June 3 and 4 at Washington.

Every task accomplished is a source of satisfaction to those who participate in the performance, and so every society represented at the Washington conference has felt a thrill of pride at having been a part of the first movement offering a chance and a definite program for united service. Those societies who were so unfortunate as not to be represented, as the facts become known to them, will begin to wonder why they were so indifferent. This is particularly true of the local society which finds in its local affairs only intermittent opportunities to expend its energies. Though local matters are the first that should receive engineers' attention, they are the soonest settled, while as the broader fields of service are approached the necessity for longer and more persistent effort rapidly develops. The opportunity afforded by the new organization to every local society to make its voice heard and take a part in the great affairs of the nation will certainly stimulate activity and interest in their members.

The effect of the organization on the national societies will be probably less apparent than on the smaller associations. They have long imagined that they were performing a great work and they will view the new organization as more or less of a side issue. Through it they will be able to exert a more effective influence on national and state questions, but the reaction will be of less importance than in the case of local and state organizations. Those technical matters in which the national societies are now coöperating seem unlikely to be affected, as the energies of the new organization will be absorbed in the solution of broader problems.

When it comes to such questions as a National Department of Public Works, the attitude of government toward the transportation industries of the country, the safe-guarding of national resources, and the protection and development of the laboring class, the new organization affords the long-looked-for opportunity for that group of our citizens best qualified by education and experience, to place before the public and the legislators its recommendations and its criticisms.

GARDNER S. WILLIAMS.

Ann Arbor, Mich.

Federation Dues and Local Societies

TO THE EDITOR:

We all recognize that The Federated American Engineering Societies should do a great deal to stimulate the professional spirit of the engineer, as it will emphasize his relations to the public and to national affairs. However, it is even more important for the engineer that he take an interest in state and local affairs of an engineering nature. This can only be done if the idea of the Federation is carried down into the smaller units so that in every locality sections of the national societies and other engineering organizations are affiliated together and these affiliations are also carried out for the various states. This aspect is of course recognized in the constitution of The Federated American Engineering Societies, but I feel that active steps should be taken to further it at the very beginning of the organization.

The only difficulty for the average local society in coming into the Federation is the question of expense. Where a society has been very active in increasing its membership and has kept its dues at a low figure, say, $5.00, so as to reach the largest number, membership in the Federation will take 20 per cent of its annual budget. Furthermore, where the society is largely made up of members of national societies, some objection may be made to an increase in dues on the ground that payment has already been made through the national organizations. On the other hand, it is extremely important that as far as possible these local societies should become members of the Federation. It seems to me, therefore, that before these societies are asked to definitely decide the question of joining the Federation, a careful estimate should be made of the activities and expected expenditiures and also the anticipated revenue of that organization. The possibilities of increased activities or of smaller payments should also be carefully pointed out. The possession of this information will help materially in the discussion of the finance committees and councils of local societies.

I hope that it will be possible to get practically every engineering organization of the country into The Federated American Engineering Societies.

JAMES A. HALL.

Providence, R. I.

A Criticism of the New Federation

TO THE EDITOR:

The constitution of The Federated American Engineering Societies makes two distinct and notable contributions to the progressive upbuilding of engineering as a profession, first through the avowal that the prime object of the organization is "to further the public welfare," and again in its stand "for principle of publicity and open meetings." This latter provision sounds a new note in quasi-public organizations.

But elsewhere in this constitution and by-laws one fails to discern any desire to get away from the traditional type of organization which has heretofore trammelled American engineering bodies especially in their work for the public.

Of vastly greater importance, however, than any possible defects in the type of organization adopted is the complete failure to recognize the necessity for enlisting the interest—aye, the enthusiasm—of the rank and file of the profession if we are to accomplish even a tithe of the task which the times demand of us.

In bringing about a union of all the engineering societies in the United States we are seeking fundamentally to effect three things:

1 The solidarity of the profession
2 To have our group thus unified, accept its public responsibilities, and
3 Gradually to develop and then to use the collective initiative thus created for the accomplishment of great public purposes.

The engineers of the United States today number at least 100,000—possibly 200,000. Within a decade or two it is not impossible that this may be increased to 500,000. Anything short of an effort to bring every one of these engineers individually into the fray by giving them a direct vote and otherwise, would be in the first place to go counter to every modern tendency in democratic theory, but of even greater immediate importance, it would deprive the new Federation of the most obvious means of educating and gradually enthusing the rank and file. This is just the kind of opportunity which was missed in the failure to provide that the members of the American Engineering Council should be elected by the votes of the members of constituent organizations rather than by the boards of these organizations.

In fact, the whole conception of the new Federation as expressed in its scheme of organization appears to be short-sighted almost to the point of insuring failure. This is not so much because it creates a typical super-organization but rather in its failure to recognize that power of the kind that makes for righteousness and the public welfare is grounded in the activities and devotion of the whole body—whatever that body may be, a ball team, a technical organization or the whole people. The effort in creating the Federation seems to have been to provide a board which could speak for the engineering profession rather than so to integrate the whole profession that when it speaks it will

1 Have something to say, and
2 In saying it carry reasonable conviction.

Still we must hope that this last effort at unity in the profession has something real to contribute, for deep in our hearts we engineers have a mighty purpose to fulfill—a purpose which cannot and will not long be thwarted and which only needs organization to make it effective.

MORRIS LLEWELLYN COOKE.

Philadelphia, Pa.

Determination of Fiber Stress Caused by Force Fits

TO THE EDITOR:

Having read with interest Mr. Wm. W. Gaylord's communication on the Strength of Thick Hollow Cylinders in MECHANICAL ENGINEERING for April, I am led to submit the two accompanying alignment charts which I have recently constructed for the determination of stress in thick hollow cylinders as applied to force fits. These charts are based on Birnie's formula for thick hollow cylinders, adapted to the case where the external pressure is zero—given in Fig. 2—in which

f_t = maximum fiber stress
e = allowance, or difference between inside diameter of hub and diameter of shaft
E_s = modulus of elasticity of shaft
E_h = modulus of elasticity of hub
R_s = radius of shaft
R_h = outside radius of hub.
$A = f(R_s, R_h)$

Fig. 1 has been constructed to obtain the value of A in the formula and Fig. 2 to obtain the value of f_t, A having been previously determined. Their use can best be explained by the solution of a definite problem.

Assume a steel shaft 2½ in. in diameter ($R_s = 1\frac{1}{4}$ in.) to be forced into a cast-iron hub 5½ in. outside diameter ($R_h = 2\frac{3}{4}$ in.) with an allowance (e) of 0.0025 in. Assume also that $E_s = 30,000,000$ for steel and $E_h = 28,000,000$ for cast iron.

Solution:

1 Lay a straight edge across the two points $R_s = 1\frac{1}{4}$ in. and $R_h = 2\frac{3}{4}$ in. of Fig. 1 and read $A = 1.854$ on the A-scale.

2 Obtain point u by laying a straight edge across the two points $A = 1.854$ and $E_h = 28{,}000{,}000$ on Fig. 2 and noting where it intersects the vertical ungraduated scale.

3 Connect points $e = 0.0025$ in. and $R_s = 1\frac{1}{4}$ in. by the line st.

4 Draw through point u a line uv parallel to st and read on the horizontal scale $f_t = 21{,}000$ lb. per sq. in. An algebraic solution of the two equations gives $A = 1.8542$ and $f_t = 20{,}970$ lb. per sq. in.

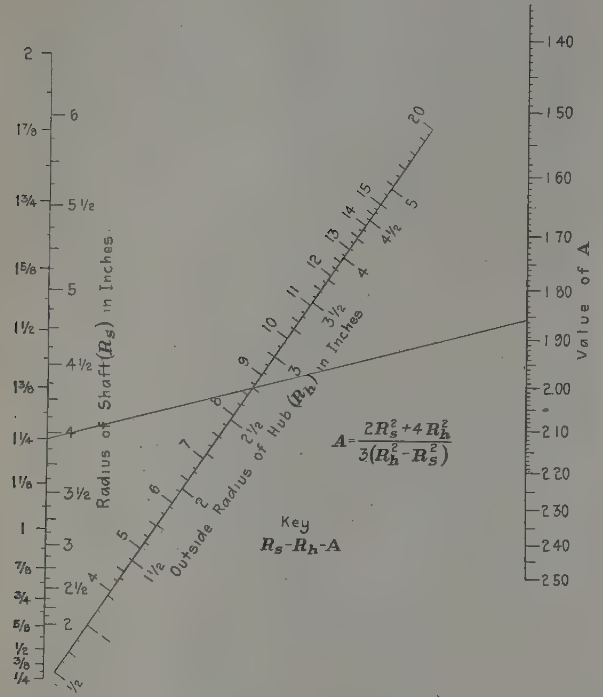


Fig. 1 Fiber Stress Caused by Force Fits. Chart for Determining Value of A in Birnie's Formula (see Fig. 2)

It will be noticed in Fig. 1 that for small values of R_s and R_h (below $R_s = 2$ in. and $R_h = 5$ in.) the points determining the straight line are very close together, and therefore the position of the line cannot be accurately determined. To obtain more accurate values of A in this region, a second scale has been added to the R_s- and R_h- axes. The outside graduations of these axes are for values of R_s from $\frac{1}{4}$ in. to 2 in. and R_h from $\frac{1}{2}$ in. to 5 in., while the inside range is for R_s from 2 in. to 6 in. and R_h from 4 in. to 20 in. In either case the straight line cuts the value of A on the right-hand scale.

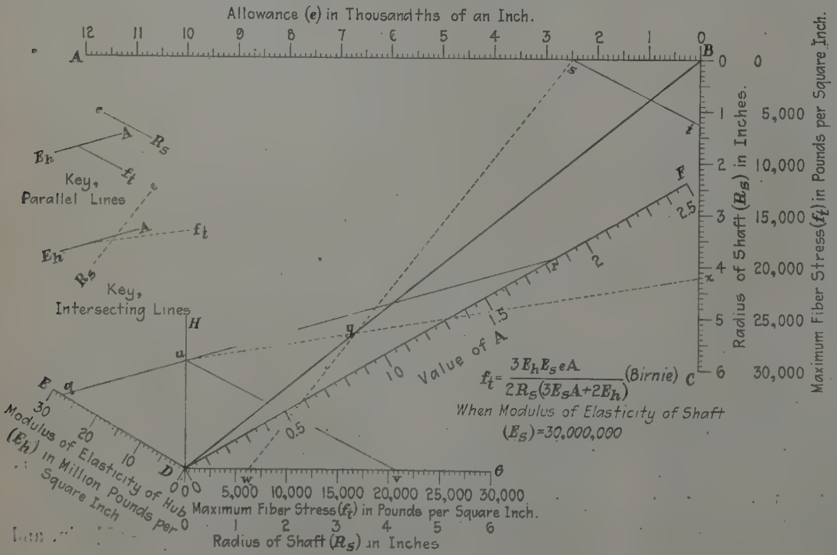


Fig. 2 Chart for Determining Maximum Fiber Stress (f_t) Caused by Force Fits

It will also be noticed that in Fig. 2 the f_t- and R_s- scales have been so constructed that they are the same length and their graduations of the same length. If, then, these two scales be interchanged, which simply means interchanging the numerical values, the scales being identical, a chart will be obtained for intersecting index lines instead of parallel index lines. The secondary values on these two scales are for that purpose. The solution of the problem for intersecting lines is shown by the dotted lines and is obtained as follows:

1 In Fig. 2 draw line qur as before.

2 Connect points $e = 0.0025$ in. and $R_s = 1\frac{1}{4}$ in., R_s now being on the horizontal scale (line sw).

3 Draw a straight line through the intersection (y) of the line sw and fixed diagonal DB, and point u and at x read $f_t = 21{,}000$ lb. per sq. in. on the secondary values of vertical scale BC.

The use of intersecting index lines has certain advantages and disadvantages, as has also the use of parallel index lines. The chart of Fig. 2 has the advantage of using either or both together, taking the mean value of the two results. The original pencil-line charts give very accurate results, but their accuracy, of course, decreases through reproduction on a smaller scale.

The A-scale of Fig. 2 need not have been graduated below $A = 1.333$, for A can never be less than that value for positive values of R_h and R_s. The scales may also be extended to any desired limits.

It will be noticed that a chart f this type has one very great advantage over that of the ordinary logarithmic chart, in that the scales are all natural scales, i.e., not logarithmic, and therefore the graduations do not close up and become very small at one end. For example, a fiber stress of 29,300 lb. per sq. in. is just as easy to read from the chart as one of 11,300 lb., and if the scale were continued to 100,000 lb. it would still be just as easy to read, which would not be true of a logarithmic scale.

S. R. Cummings.

Cambridge, Mass.

Load-Speed Capacities of Radial Ball Bearings

To the Editor:

The purpose of this communication is to arouse interest in a subject, often incorrectly treated, with a view of pointing out a correct solution. Ball bearings are in such general use and under such varied conditions that the engineer must have an accurate formula for calculating their strength.

There are at present two widely used formulæ for figuring the load-speed characteristics of radial or annular ball bearings. One is the Hess-Bright or D.W. F. formula—

$$W = knd^2$$

In which W=load in lb.
n=number of balls
d=diameter of balls in eighths of an inch
k=a constant varying with the condition and type of bearing, as also with the material and speed.

The second formula is that worked out by Professor Goodman—

$$W = knd^2/(RD + Cd)$$

In which W=load in lb.
n=number of balls
D=diameter of outer ring race in inches
d=ball diameter in inches
R=r.p.m.
K and C= constants having the values given below:

	C	k
Thrust bearings, flat races	200	500,000
Thrust bearings, grooved races	200	1,000,000 to 1,250,000
Radial bearings, flat races	2000	1,000,000
Radial bearings, grooved races	2000	2,000,000 to 2,500,000

As correctly stated by the authors of the Hess-Bright formula, the capacity of a bearing increases in direct proportion to the number of balls and the square of the ball diameter. The capacity decreases with the speed and varies with the type and material of the bearing. All of the variables last mentioned have been combined by some method in the constant k. From the writer's experience it would seem that a value of k must be worked out for every speed. This makes it a somewhat overworked constant and harder to assign a value to it than to figure the load-speed characteristics on a more rational basis.

Let us look at the Goodman formula with these points in view. We find that the load increases with the number of balls, and, since d^3 is expressed in the numerator and d in the denominator, with the square of the ball diameter. The correctness of these facts is agreed to by all ball-bearing formulæ. We also find that the capacity decreases with the speed, which is quite obviously true. It also decreases with an increase in the diameter of the outer ring race, or in other words the diameter of the enclosing circle around the balls. We will see the logic of this assumption if we consider two bearings identical in number and size of balls but one having an outer ring race of greater diameter than the other. If the balls are evenly spaced there will be a greater length of arc between balls in the larger bearing than in the small one, and this naturally gives rise to a greater chance for deflection in the outer ring. We have left two constants which vary as shown in the table only for certain specific conditions, a value therefore being easily given them.

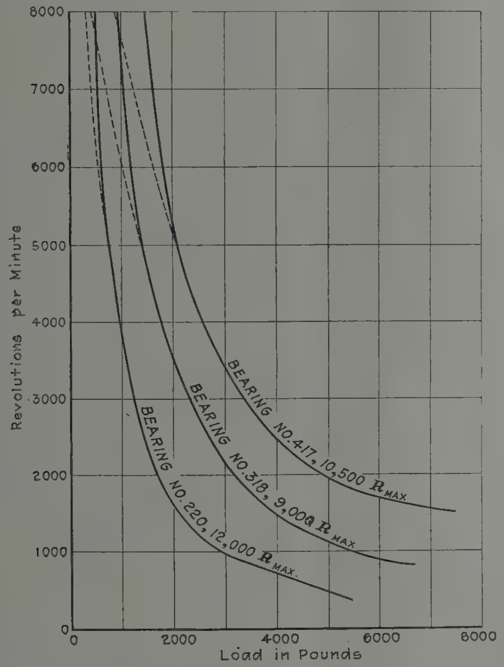


Fig. 3 Variation of Load Composition of Representative Ball Bearings with Speed in R. P. M.

It appears from the foregoing that the Goodman formula is by far the more logical. There is, however, one consideration that this formula, and in fact all formulæ, neglects, namely, the maximum speed at which a bearing may be run. As shown in Fig. 3, which graph was obtained by plotting the Goodman formula for a few representative bearings, the curves reach zero load or their maximum speed at infinity. The curves shown by solid lines are the values given by Goodman and the additional dotted lines are a modification of this formula which will be described.

A formula has been derived by the writer for the maximum safe speed of a bearing under no load. This has been worked out from the standpoint of centrifugal force and a large factor of safety is used. It reduces to—

$$R_{max.}=K\sqrt{1/(D-d)}$$

In which R_{max} = maximum safe speed under no load
D = diameter of outer ring race in inches
d = ball diameter in inches
K = a constant to which a value of 25,000 has been assigned.

This value is correct for radial bearings having raceways of a radius = 0.54 of the ball diameter, made of alloy steel hardened clear through, and of the best accuracy known to the art.

To use this formula the values given by the Goodman formula are plotted. The maximum speed is figured from the above formula and plotted on the coördinate of zero load. Through this point a line is drawn tangent to the curve previously plotted. The result obtained is shown in the graph. This results, for large bearings, in a considerable reduction in the load-carrying capacity at the higher speeds.

The writer is indebted to Mr. Harry R. Reynolds for assistance in the preparation of this communication.

R. W. Sellew.

New Britain, Conn.

Why Not a Tool-Drafting Standard?

To the Editor:

Many of our members who have been connected with the metal-manufacturing industry for many years can remember when tool drafting consisted mostly of verbal information, with perhaps a rough sketch of what was desired. This has been supplanted by more modern methods and the writer believes that tool designing and tool drafting have reached a stage today worthy of a consideration of some sort of codified standardization.

During 18 years of experience as tool maker and tool designer the writer has had the opportunity to observe many different uses of lines, letters, figures and symbols to express an idea, the majority of which failed to give a complete conception of the tools wanted. Mechanical engineers and chief draftsmen who in times of stress have had recourse to outside engineering firms to design and draw up the tooling of a new product, will vouch for the time lost in attempting to adapt drawings made by these outside firms to the system in vogue in their own drafting department. Such difficulties could be overcome if there was available some standard according to which the work might be done.

The writer suggests, therefore, that the newly created machine-shop section of the Society investigate the possibilities of an A. S. M. E. tool-drafting code whereby the best methods of expressing an idea by means of lines, letters, figures, and symbols would form some sort of universal language, the economical value of which would soon be felt.

Fred C. Friedli.

Elmira, N. Y.

New York State Legislature Passes Bill for Licensing Engineers

The bill licensing engineers in the State of New York, adopted by the legislature in April 1920, became a law on May 14, 1920, when it was signed by Governor Smith. The bill is based upon Engineering Council's recommended uniform registration law, with certain modifications and changes conforming to the provisions of e isting law, a bill requiring the licensing of architects already having been enacted. A discussion of the bill as recommended by Engineering Council may be found on pages 77 and 78 of the January, 1920 issue of Mechanical Engineering.

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A Plea for the Development of Our Water Powers

W. M. WHITE

THE people, of a right, should look to the engineer to point the way in the utilization of nature's forces which will result in the greatest relief from human toil, as they have looked in the past to the medical profession for relief from human ills. The people's faith in the good to come from the engineer's work is well expressed in the generous support given the Engineering Educational Institutions.

There has been installed recently at Niagara Falls a combined hydro-electric unit of 40,000 horsepower capacity. The operation of this unit requires two men per shift. It has been calculated that to produce the same amount of power by small isolated steam plants, as would be the case were the water power not developed, there would be required over 800 men to mine, hoist, break, screen, load, transport by railroad, unload, store, rehandle, and fire under boilers the coal necessary to develop by steam an equal amount of power. The operation of this one unit conserves not only one train load of coal per day, but also conserves the man power which would be required to produce it. This striking example shows the great amount of man power which can be conserved for other fields of endeavor by developing our water powers.

May it not be that the shortage of labor to accomplish the tasks before us today has been brought about by the failure to follow that path in the development of our natural resources which leads to the minimum of human toil?

Some time ago a member of the British Parliament pointed out in open meeting that the American workman has twice the horsepower per man behind him that the British workman has, and gave this as the reason for the ability of the manufacturers in the United States to pay to labor wages twice that paid in England and yet compete successfully in the World's markets in manufactured products. We have the power behind the workman, but the major portion of it is steam power, and we are paying a dear price for that power in men absorbed.

The economic advantage which the United States has heretofore enjoyed by reason of adequate power is being sought by other nations. For example, Japan only recently began the development of her water powers, but has already developed one and a half million of her total eight million water horsepower.

Failure to develop our water horsepowers has been seriously retarded due to a wrong conception of conservation, as manifestly there can be no true conservation as long as the power in the rivers is running to waste.

The shortage of labor which has increased the price of coal and the shortage of fuel oil, forces to our attention the necessity for the development of a large amount of our water powers during the next decade.

Laws have just been enacted governing the development of water power on Government Lands which will greatly influence hydro-electric development, particularly in the Western States. It seems a fitting task of the engineer to urge and aid the development of our water powers under the new law.

There has been developed in the United States today approximately nine million horsepower from water power, and there is yet available for development by this same means over fifty million horsepower; the development of which would save the labor of one million men.

When the war came on we were lamentably short in certain chemicals, chemical compounds and alloys. That small portion of our water powers which had been developed proved a great asset in our national crisis. That great portion of our resources in water power which was yet undeveloped was of no value in meeting the great emergency. The Government took control of the developed powers and directed their energy to war work solely. Water power centers became great producing communities in all things chemical. The energies of the great developed water powers were let loose in electric furnaces, and in electrolytic cells for making good the shortage in chemicals, chemical compounds, and alloys, but even this was not sufficient to meet the emergency. Huge steam plants were hurriedly constructed to supply additional power for this purpose, but this great construction work required labor not only for the construction, but for the operation of such plants which required enormous quantities of coal, thus absorbing man power at a time when every potential fighting unit should have been available for the front.

The development of our fifty million water horsepower now running to waste would mean not only a tremendous economic advantage to the people but a potential asset which might prove of incalculable value in case of war requiring the concentration of the man force of the nation for other than domestic uses.

Early development of the water powers would be the greatest move which could be made in the direction of true conservation.

Milwaukee, Wis. WM. MONROE WHITE.

The Important Water Power Problem

A study of the severe transportation problem has resulted in offering as a solution, vitally interesting to the engineer, the elimination of coal movements by developing the power at the mines, and uniting in one big system the power lines of the large industrial centers. Of equal interest in this problem, and of great value in the conservation of our fuel resources, is the problem of hydraulic power development.

In our desire to bring this problem home to the mechanical engineers of the country, several pages in the Survey of Engineering Progress in this issue are given to a digest of notable engineering articles covering the development of hydraulic machinery. Our signed editorial this month also bears on this problem, pointing out a conservation in man power that may be gained by greater utilization of water power.

The use of our hydraulic resources is a nation-wide question which commends itself to mechanical engineers, whether closely associated with its development or not.

The Raising of Engineering Limits

Throughout the entire field of engineering there has recently been apparent a tendency to raise the limits of working far beyond what was considered either safe or commercially practicable only a few years ago.

In the General Electric design of a super-power station, described in the August issue of MECHANICAL ENGINEERING, it is proposed to use a steam pressure of 350 lb. and superheat of 350 deg. fahr.; the implication being that pipe, valves and fittings can now be commercially produced that will not be excessive in price and yet will safely stand these high mechanical and thermal stresses. In fact, 350 lb. pressure and 350 deg. fahr. superheat are by no means the limiting values under consideration, for 600 lb. pressure has been seriously mentioned as a possibility of the near future, if not a commercial value for use today.

In the field of refrigeration we have very nearly reached the limit of possibility, as Prof. Kammerlingh-Onnes in his work has come within 3 or 4 deg. of the absolute zero of temperature. It is true that such an excessively low temperature has not as yet been applied in commercial work, but only for the reason that thus far no process has been devised where it could be used commercially.

In the field of pressures other than steam, the limits have also been raised materially. Only a few years ago engineers spoke with somewhat bated breath of pressures of 200 atmospheres used in the various Linde processes for the separation of gases. Today commercial applications are being made of pressures at least five times as high, and pressures of 1200 and 1500 atmospheres are seriously under consideration.

The ability to raise the commercially reliable engineering limits of pressure, temperature, compression, etc., is undoubtedly due primarily to two causes. In the first place, our knowledge of the behavior of materials and our ability to produce materials of uniform quality have increased tremendously. Only fifteen years ago a tensile strength of 150,000 lb. per sq. in. was considered to be about the limit of strength of commercial metals, while 250,000 lb. does not represent the possibility of some of the special alloys of today. Moreover, with our present methods of testing materials and of producing alloys, and especially with our present methods of heat-treating them, it is possible to insure that a metal part will stand up under given enormous stress where there could be no such certainty only a few years ago.

In the second place, the improvement in our methods of machining has had a powerful influence in the same direction. In this connection an interesting illustration may be cited from the field of internal-combustion engineering. The Doxford oil engine uses a system of solid injection which is effected by means of a plunger pump exerting a pressure of 6000 lb. per sq. in. The remarkable part about this pump, however, is that it uses no packing. It appears, therefore, that it has become possible to produce a plunger and cylinder with such an accurate fit that a pressure of several tons to the square inch may be generated. It is easy to see what a substantial advance this represents in the precision of machine-shop processes.

This advance, in turn, has become possible through the improvement in the machine tools themselves, and especially through the fact that they are not only built better and of better materials, but are far more massive and rigid than they used to be a few years ago.

In the 50's of the last century, when the scientific world was still being taught the full realization of the principle of the conservation of energy, a favorite illustration used to be the lighting of a match. It was said that the world represented such a closely balanced unit that the release of the potential heat-energy content in the match was immediately reflected throughout the universe. The burning of the match raised the temperature of the surrounding atmosphere that produced a flow of air upwards which resulted in a tiny wind, etc.

Practically the same close co-working of phenomena is to be observed in engineering. The improvement of materials, tools and methods of machining makes possible the use of temperatures, pressures and compressions greater than any that have been used before. This, in its turn, calls attention to the economies and possibilities of the higher limits and calls for new efforts to improve still further the materials, processes, and machinery of production.

As a matter of fact, some very remarkable results in machining to close limits have been attained in the production of gages, as, for example, the Johanssen and Hoke precision gages. A remarkable part of this work is the ability of the gage makers to produce surfaces of such flatness that when two blocks are put together they adhere to each other with great force.

The production of such surfaces today is of value mainly in such a limited field as gage manufacture, but it would not be at all surprising, as stated by Mr. Johanssen, if a step further in the same direction would bring about a rather revolutionary process of joining metals. Gage blocks are already machined with such precision that when the surfaces of two such blocks are put together it takes a force of hundreds of pounds to tear them apart. One step further and it might become possible to produce blocks with two such perfect surfaces that when brought together they would exert upon each other their full molecular attraction, and, to all practical purposes, become one. In other words, welding by heat, which is nothing but bringing two metals to a state in which molecular attraction becomes possible, might be replaced by machining the two parts to a condition where the same result would be brought about.

Such an accomplishment admittedly would be difficult and probably impossible under our present knowledge. It is mentioned, however, as an illustration of the great new fields that loom ahead of the modern engineer and that have been brought within the range of possibility by the extension of our knowledge of producing and handling engineering materials.

Observations on the Work of the National Public Works Department Association[1]

The technical men who started the public works movement ought to know the accomplishments to date so that they may plan wisely for the future. This is a period of recess in legislative matters and we are given an opportunity to derive lessons from the events of the past. The National Public Works Department Association therefore submits this review with confidence that the supporters of the movement will have no reason to regret their participation therein.

Like all other movements of this kind, there are stages in which there is much visible progress and others in which development can be discerned only by those in intimate touch. We are now in one of the latter stages in which the principal effort is the preparation for achievement at the fall session of Congress. There could be no final success without these interim developments for they are as necessary to the final enactment of the measure by Congress as is the President's approval of the finished document following its passage.

We have won decisively in the first phase of this campaign, which is the establishment of the underlying principle. If every indication can be believed a Department of Public Works will be created. The leaders of Congress are in agreement on the principle and some of them are working on its details during the present legislative recess. The candidates for president and vice-president in both great parties have signified their approval and in this they are in step with the great leaders of thought and action the country over.

The second phase of the campaign, which consists of securing the right kind of a department of public works, will be more laborious than the first. It involves the minute consideration of details, the sifting of evidence and the presentation of the results in convincing form. The supporters of this movement should not make the mistake of believing that the campaign is over merely because the principle has been accepted. It is obvious that the wrong kind of a Department of Public Works will be as bad if not worse than the present organization of governmental functions.

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[1] The National Public Works Department Association is a league composed of individuals, associations and of national, state and local societies, having an aggregate membership of over 100,000 business men, engineers, architects, constructors, manufacturers, chemists, geologists and economists. Its purpose is to organize under one department the many and varied public works functions of the Federal Government. M. O. Leighton is chairman of the Association, and C. T. Chenery, secretary. The Association's headquarters are in the McLachlen Bldg., 10th and G St., Washington, D. C.

The most troublesome as well as the most inexcusable setback has been the failure of the movement in the referendum of the United States Chamber of Commerce. This was plainly due, first to the lack of adequate publicity, and second, to the inaction of the local engineering bodies which were depended upon to take care of the issue in their own local commercial organizations. Our finances would not permit us to handle the first, but we had every good reason to expect diligence on the part of "our own crowd" in the second. Evidence is constantly being accumulated that the important commercial bodies which voted adversely on that referendum did so in ignorance of the character, intent, and purport of the movement.

The principles underlying the public works movement—economy and efficiency and businesslike conduct of the Government's affairs—are not confined to the public works functions. The need is apparent in every line of Government functions. The Republican Party, for example, has adopted the principle as one of the planks in its platform. Reorganization of all departmental functions is as certain and steadfast a part of the Congressional legislative program as any other feature now before the public. It has been remarked in places that the public works department advocates may have done their job too well and have put forward so logical and persuasive a set of facts and principles that they must perforce be applied to the entire government structure with the possibility that the creation of the public works department may be delayed pending reform of all government functions. We are assured, however, that there will be no danger of such a result if the technical men of the country faithfully continue their activities on behalf of a public works department.

One of the most persuasive arguments against a proposal to delay the public works feature pending the announcement of a general reorganization bill is that previous efforts toward general reorganization have failed, first, because of the size and complexity of the job and, second, because it encountered so many points of opposition in the Federal bureaus. It is the opinion of such leaders in Congress as Senators Smoot of Utah and McCormick of Illinois, of Speaker Gillett of the House and of Representatives Madden of Illinois and Reavis of Nebraska that success will depend on the selection of one set of functions and the logical adjustment of them so that the underlying principle may be established in statutory form. It is agreed that the first and most logical set of functions is that which comprises the nation's public works.

From the present until the convening of Congress on the first Tuesday of December next, the engineers, architects, and technical men of other branches throughout the country have a rare opportunity to further this movement, because Congress is in recess and the representatives are at home. If each man who is convinced of the necessity for this reform would embrace this opportunity to instruct his representative in Congress and to enlist his active coöperation in the furtherance of this legislation, progress at the next session of Congress would be rapid and certain. For the present, members of Congress are almost out of reach of the Association's officers. The field of intensive effort has shifted "back home" where the technical men of the country may render "first aid."

Washington, D. C. M. O. Leighton.

Report on Industrial Conference Available

The American Society of Mechanical Engineers has on file at headquarters a limited number of copies of the Report of the Industrial Conference called by the President on December 1, 1919. The Society will be glad to furnish copies to those interested.

Charles Whiting Baker Retires from Journalism to Enter New Field

Charles Whiting Baker, Mem.Am.Soc.M.E., formerly editor-in-chief of *Engineering News* and later consulting editor of *Engineering News-Record*, announces his retirement from engineering journalism, in which he has so long been identified, to become managing director of a new service for the engineering and technical industries. Realizing the difficulty often experienced in bringing together those who have engineering properties to sell, and possible purchasers who have had experience in the fields of these industries and are qualified to manage them, Mr. Baker is to establish an engineering business exchange where owners and qualified customers may conveniently meet.

Mr. Baker has been connected with engineering journalism for thirty-four years, during twenty-two of which he was editor-in-chief of *Engineering News*. Readers of this publication and of *Engineering News-Record* are quite familiar with the illuminating quality of his writings and the breadth of view so often expressed in his editorial comment. As editor of a journal of civil engineering, he had to deal with much construction work of a public character, and his editorials have consistently discussed the broad aspects of such enterprises in which the public is vitally concerned. He has never been one of those who regard the field of engineering as restricted to the materials, the laws, and the forces of nature. On the contrary, he has been a pioneer in advocating the close association of the engineer with matters concerning the public interest and the human relations of society—matters which are now so much discussed in connection with the formation of the Federation of the American Engineering Societies.

In wishing Mr. Baker unqualified success in his new undertaking, we must also tell him that in the years to come we shall greatly miss his frequent and valued contributions to the technical press—we hope they still may be occasional.

Minnesota Proposes State Federation of Architects and Engineers

Representative architects and engineers from all parts of Minnesota recently met at Duluth and took the first step toward the organization of a State Federation of Architects and Engineers. The unanimous sentiment of those in attendance, reports *The American Architect*, was in favor of such a federation. Only by unification into one state-wide organization will the engineers and architects of Minnesota have the power and weight of numbers behind them to force attention to matters of public concern, having to do with problems of engineering and architecture, or with the regulation of affairs affecting their joint interests.

It was pointed out by Max Toltz, chairman of the meeting, that there are about 4800 engineers, architects, and draftsmen in Minnesota. Many of these men are not identified with any existing organization. It is not the purpose of the men who are back of the proposed federation to supplant any existing organization.

National Research Council Elects New Officers

The National Research Council, which was organized in 1916 under the direction of the National Academy of Sciences, has just elected new officers for the year beginning July 1, 1920. These are as follows: Chairman, H. A. Bumstead, professor of physics and director of the Sloane Physical Laboratory, Yale University; First Vice-Chairman, C. D. Walcott, president of the National Academy of Sciences and secretary of the Smithsonian Institution; Second Vice-Chairman, Gano Dunn, president of the J. G. White Corporation, New York; Third Vice-Chairman, R. A. Millikan, professor of physics, University of Chicago; Secretary, Vernon Kellogg, professor of biology, Stanford University; Treasurer, F. L. Ransome, treasurer of the National Academy of Sciences.

The National Research Council was one of the potent factors in development of scientific and research problems during the war. Originally created to deal with such problems, it was reorganized in 1918 on a peace-time basis and is now functional through five divisions, namely those of Physical Sciences, Engineering, Chemistry and Chemical Technology, Geology and Geography, and Biology and Agriculture.

U. S. Chamber of Commerce Records Its Views on Industrial Relations

Overwhelming approval of a platform setting up twelve principles of industrial relations has been given by the membership of the Chamber of Commerce of the United States in a referendum vote, the result of which were recently announced. The vote taken was on the report of a special committee of the Chamber's board of directors. This report went deeply into the subject of the employment relation and recommended among other things recognition of the right of open-shop operation and the right of employers and employees to deal directly with each other without participation by outside interests.

At the same time the Chamber's membership in another referendum vote has approved a report of its Committee on Public Utilities recommending that strikes by public-utility employees should be explicitly prohibited and that tribunals should be created by law to adjudicate in decisions binding on both parties differences between public utilities corporations and their employees. The vote on the two referenda was the largest ever recorded by the Chamber on any subject.

Sir Robert Hadfield Prize

Sir Robert A. Hadfield, D.Sc., D.Met., F.R.S., has placed in the hands of the Institution of Mechanical Engineers (England) the sum of £200, the income therefrom to be awarded at the discretion of the Council of the Institution as a prize, or as prizes, for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness.

Competitors should familiarize themselves with the ordinary tests of hardness, such as are described in the Report of the Hardness Tests Research Committee (*Proceedings* of the Institution of Mechanical Engineers, 1916, pages 677 to 778). What is desired is the description of a research for or an investigation of some method of accurately determining hardness, suitable for application in metallurgical work in cases in which present methods partially fail.

The Council of the Institution will consider annually all communications received, and may then award a prize or prizes. But in January, 1922, the offer of prizes will be withdrawn, and any unexpended balance of the Prize Fund will be diverted to any other purposes to be determined at the discretion of the Council.

Communications should be accompanied by scale drawings of any new apparatus described, or by a model or an example of the apparatus itself. If the communication describes a new invention likely to be of commercial value, it is desirable that provisional protection should have been obtained before it is submitted for consideration. Communications should be addressed to The Institution of Mechanical Engineers, 11 Great George Street, Westminster, London, S.W. 1.

Monument to Wilbur Wright Is Presented to Le Mans

Tribute to the life and work of Wilbur Wright, American pioneer in aviation, was recently paid by the unveiling in Le Mans, France, of a superb monument. The occasion of the unveiling, on July 17, was a notable one, being attended by a large number of prominent Frenchmen and Americans.

Speeches were made by Baron d'Estournelles de Constant, president of the Wilbur Wright Committee; M. Castille, Mayor of Le Mans; Rear-Admiral T. P. Magruder, representing Hugh C. Wallace, the American Ambassador to France; Comte Henri de La Vauls, M. Stephen Lausanne and Mr. Myron T. Herrick, former United States Ambassador. The dedication exercises concluded with the presentation of the Grand Cordon of the Legion of Honor to Louis D. Beaumont, donor of the monument, a governor of The Aero Club of America, and a prominent patron of aviation during the war.

The Wilbur Wright monument, facing the east in the Place des Jacobins, is the work of the French sculptor Paul Landowski and the architect Bigot. Standing 40 ft. high, its base is carved with figures in bas-relief of Wilbur and Orville Wright and of Léon Bollée. It also carries the names of the precursors of aviation from the time of Dedalus, listing the heroes who gave their lives for the development of the science. It upholds at its summit the splendid figure of a man reaching to the skies.

THE WILBUR WRIGHT MONUMENT

Admiral Magruder, who represented the American Ambassador, spoke in French. He said in part:

> The names of Wilbur and Orville Wright have added themselves to those of the great American inventors, Fulton, Howe, Morse, Edison, and I am proud of the thought that my fellow-citizens have contributed to give the world a finer life than before. Americans are a practical race. What I admire among you, my friends of France, is that you know how to join the ideal with the practical. One will never forget the names of Latham, Blériot, Pégoud, aviators before the great war. During the war, Wright's invention permitted other Frenchmen to make themselves ever famous—Garros, Gilbert, and the incomparable master of the air, Guynemer.

Under the Admiral's supervision a stalwart American marine placed a wreath at the foot of the statue, the gift of the townspeople of Wilbur Wright's home, Dayton, Ohio.

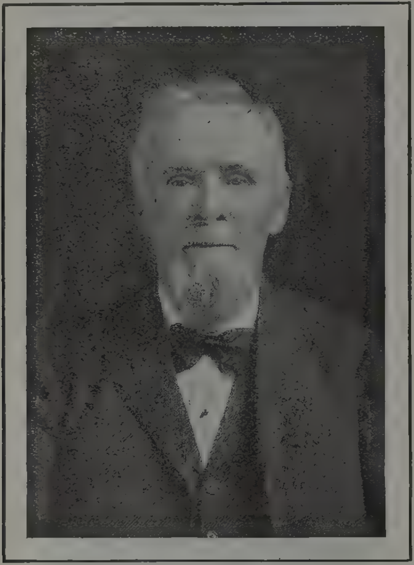
Former Ambassador Herrick recalled the prominence of his home state, Ohio, which has given Edison and the Wrights to civilization, and rehearsed the steps which brought Wilbur Wright to France in 1908. He also lauded the names of American inventors from the time of Fulton and Franklin, revealing their close relation, in their final success, to France and French assistance, and he concluded with a fervent appeal for the fostering of a common Franco-American spirit.

Amos Whitney Dies

Amos Whitney, one of the most conspicuous figures in the early growth of the New England machine-tool industry, a member of the A.S.M.E. since 1913, died on August 5, at the Poland Springs House, Poland Springs, Me. Mr. Whitney was born 88 years ago on October 8, 1832, in Biddeford, Me. He came from distinguished Colonial and English ancestry. In this country the family has continuously held a prominent place, many of its members showing decided mechanical tastes as Eli Whitney, inventor of the cotton gin, Baxter D. Whitney, the Winchendon machine builder, and Amos Whitney.

He was apprenticed at the age of 14 to the Essex Machine Co. of Lawrence, Mass. Six years later he moved to Hartford where he was employed at Colt's Armory, at that time the headquarters for many New England mechanics.

There he met Francis E. Pratt, who left shortly afterward to take charge of the Phoenix Iron Works, and Asa A. Cook. In 1853 Mr. Cook also went to the Phoenix Works as a contractor, taking young Whitney with him as a full partner. While there Mr. Whitney became closely associated with Mr. Pratt, who designed the "Lincoln" milling machines. Whether the idea of the milling machine came originally from Windsor, Vt., as some claim, or originated in Hartford, is difficult to prove at this time; but at any rate the machine is known as the Lincoln milling machine all over the world. In 1860 they determined upon entering business together. They rented a small room where, in addition to their regular employment, they started the manufacture of a little machine for winding thread known as a spooler. Within two years the business had increased to such an extent that they gave up their positions at the Phoenix Works and in 1865 erected their first building on the present site. In 1869 the Pratt & Whitney Co. was formed with a capital of $350,000, later increased to $500,000, and in 1893 reorganized with a capitalization of $3,000,000. In 1893 Mr. Whitney was made vice-president; later he was president, in which office he continued until January 1901, when the control of the company was acquired by the Niles-Bement-Pond Co. Mr. Whitney remained as one of the directors.



AMOS WHITNEY

Mr. Whitney's unbounded optimism was well displayed when the Pratt & Whitney Co. went through its first panic. It kept right on making standard machine tools, but selling almost nothing, until all the available storage room was filled. Then a large space was hired from the Weed Sewing Machine Co. and when this was filled another large space was hired in Colt's "West Armory" and this in turn was filled with finished machinery. It is well to note as a matter of history that when this immense stock finally did begin to move, it was practically sold out in 30 days.

Mr. Whitney took an important part in the development, in this country, of standard measuring instruments, one of the first moves being a determined effort to secure a standard inch block. His company purchased at considerable expense a standard rectangular bar, 1 in. square and 12 in. long, which had been used as a standard of measurement. Twelve 1-in. cubes were then made as accurately as possible and tested by the 12-in. piece. It was found that the twelve 1-in. cubes were not as long as the single bar, supposed to be exactly 12 in. long. Careful measuring and comparison with such standard instruments as were available led the company to believe that the individual inch-blocks were more nearly accurate than the long piece, and this was afterwards proved by the Rogers-Bond comparator, which was developed in the Pratt & Whitney Works.

At the time of his death Mr. Whitney was president of the Gray Telephone Pay Station Co., and treasurer of the Whitney Manufacturing Co., Hartford, which was organized by his son, Clarence.

Death of Isham Randolph

Isham Randolph, consulting engineer and for fourteen years chief engineer of the Sanitary District of Chicago, died on August 2 in that city. Mr. Randolph was born in Clarke County, Virginia, in 1848. At the age of 20 he started work as an axeman for the Winchester & Strasburg Railroad, thus beginning a long career in which railroads played so large a part.

From 1880 to 1885 he was chief engineer of the Chicago & Western Indiana Railway and the Belt Railway of Chicago, at the end of which period he began private practice in Chicago. The following year he became chief engineer on the construction of the Chicago, Madison & Northern Railway and Freeport & Dodgeville Railway for the Illinois Central Railroad. In 1888 he resumed general practice in Chicago, and was consulting engineer for the Union Stockyard & Transit Co., the Calumet Terminal Railway, and the Baltimore & Ohio Railroad. From 1893 until 1907, when he resigned he was chief engineer of the Sanitary District of Chicago. He was retained, however, as consulting engineer until the end of 1912.

In 1905 Mr. Randolph was appointed by President Roosevelt on the Board of Consulting Engineers for the Panama Canal, and he was one of the five members of the board whose minority report was accepted by the President and Secretary of War, approved by the Panama Commission and adopted by Congress. Again, in 1908, he was one of the six engineers who accompanied President-elect Taft to Panama to consider the advisability of changing the plans for the Canal.

He was chairman of the Internal Improvement Commission of Illinois which made plans for a canal from Lockport to Utica, Ill., of the State Conservation Commission, of the State Rivers and Harbors Commission and of the Chicago Harbor Commission. He made an engineering study, report and plans for a commercial harbor for Milwaukee and was consulting engineer. From 1893 until 1907, when he resigned, he was chief engineer for Toronto and Baltimore on track-elevation work. He served as a member of the Toronto Water Supply Commission. He was also consulting engineer for the Little River Drainage District of Cape Girardeau, Mo., and reviewed the plans and estimates for the Lake Erie and Ohio River Barge Canal. He was chairman of the Florida Everglades Engineering Commission and made a complete report on the drainage of the swamp lands of Florida. The report was accepted by the Governor. He designed the harbor system for Miami, Fla. Upon appointment by the Queen Victoria Niagara Falls Park Commission he designed the Obelisk dam above the Horse Shoe Falls.

Mr. Randolph was past-president of the Western Society of Engineers, and a member of the American Society of Civil Engineers and the American Institute of Consulting Engineers.

The Federated American Engineering Societies

The Joint Conference Committee, which is acting for The Federated American Engineering Societies in accordance with the instruction of the Organizing Conference held in Washington, D. C., June 3-4, 1920, has sent out to approximately 150 engineering and technical organizations an invitation to become a charter member of the new Federation. An invitation has also been extended to the same societies to appoint delegates to the first meeting of the American Engineering Council which is being planned for this fall and of which more extended notice will be given later.

Copies of the constitution and by-laws of the Federation have also been sent to the above societies. This constitution, which is printed below in full has just been released for publication in accordance with the instruction of the Washington Conference who referred it to an editing committee for revision. Mechanical Engineering presents this constitution and by-laws with the hope that its readers will study the form of the new organization which is being set up, for as time goes on changes will doubtless be made, and if the Federation is to prosper it is necessary that these modifications be made in the light of widespread criticism. To this end Mechanical Engineering will welcome correspondence dealing with all matters pertaining to the Federation.

Constitution

PREAMBLE

Engineering is the science of controlling the forces and of utilizing the materials of nature for the benefit of man, and the art of organizing and of directing human activities in connection therewith.

As service to others is the expression of the highest motive to which men respond and as duty to contribute to the public welfare demands the best efforts men can put forth, Now, Therefore, the engineering and allied technical societies of the United States of America, through the formation of The Federated American Engineering Societies, realize a long-cherished ideal—a comprehensive organization dedicated to the service of the community, state, and nation.

ARTICLE I. NAME

The name of this organization shall be The Federated American Engineering Societies.

ARTICLE II. OBJECT

The object of this organization shall be to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions.

ARTICLE III. MEMBERSHIP

Section 1. *Scope.* The membership may consist of national, local, state and regional engineering and allied technical organizations and affiliations, classified as follows:

1 National engineering and allied technical organizations

2 Local, state, and regional engineering and allied technical organizations other than local associations, sections, branches, or chapters of national organizations

3 Affiliations consisting of any one or a combination of the following constituents:

(*a*) Local sections, branches, chapters, and associations of members of national organizations included under (1)

(*b*) Local engineering and allied technical societies and clubs, not of national scope

(*c*) Local engineers and members of allied technical professions and their associates.

Section 2. *Qualifications.* The qualifications for membership shall be as provided in the By-Laws.

Section 3. *Application for Membership.* Application for membership shall be made in the form and manner prescribed in the By-Laws.

Section 4. *Termination of Membership.* The membership of any constituent organization may be terminated by it or by the American Engineering Council in the manner provided in the By-Laws.

ARTICLE IV. MANAGEMENT

Section 1. *Managing Body.* The management of this organization shall be vested in a body to be known as "American Engineering Council," and its Executive Board.

American Engineering Council

Section 2. *Functions.* The American Engineering Council shall consist of representatives of Member-Societies selected as hereinafter provided. This council shall coördinate the activities of state councils and of local and regional affiliations whenever these activities are of national or general importance or may affect the general interests of engineers.

Section 3. *Representation.* Each national, local, state, and regional organization and affiliation shall be entitled to one representative on the Council for a membership of from one hundred to one thousand inclusive and one additional representative for each additional one thousand members or major fraction thereof; provided, that in the determination of the representation of local, state, and regional organizations and affiliations no count shall be taken of any organization which is represented individually or through another local, state or regional organization or affiliation; and, provided further, that no organization shall have more than twenty representatives on the Council.

Section 4. *Selection of Representatives.* Representatives on the Council shall be selected as stipulated in the By-Laws.

Section 5. *Meetings.* The Council shall hold an Annual Meeting. Other meetings may be called by the Executive Board and shall be called by it upon the written request of twenty-five representatives on the Council.

Section 6. *Officers.* The elected officers of the Council shall consist of a President, to hold office for two years, who shall be ineligible to reëlection, four Vice-Presidents, to hold office for two years, two to be elected each year, and a Treasurer, to hold office for one year. These officers shall be elected by a letter ballot of the representatives on the Council as provided in the By-Laws. There shall be an Executive Officer who shall also be Secretary appointed by and holding office during the pleasure of the Executive Board. He shall not be a member of the Executive Board but may be a representative on the Council.

Executive Board

Section 7. *Functions.* There shall be an Executive Board of the Council constituted as hereinafter provided and charged with conducting the business of the organization under the direction of the Council.

Section 8. *Membership.* The Executive Board shall consist of thirty members, of whom six shall be the officers elected by the Council and twenty-four shall be selected, a part by the national societies, and the remainder by the local, state and regional organizations and affiliations according to districts, as provided in the By-Laws; provided, that the number of members representing the national societies on the Executive Board shall bear as nearly as may be the same ratio to the number of members representing the local, state and regional organizations and affiliations thereon, as the number of representatives of the national societies on the Council bears to the number of representatives of the local, state and regional organizations and affiliations thereon.

Section 9. *Electoral Districts.* For the purpose of facilitating the selection of the district members on the Executive Board the Council shall, as provided in the By-Laws, divide the United States into districts based upon an equitable representation, having regard to both its membership and area.

Section 10. *Officers.* The President and Secretary of the Council shall be, respectively, the Chairman and the Secretary of the Executive Board. There shall be two Vice-Chairmen, elected by the Board from its members.

ARTICLE V. UNEXPIRED TERMS

Vacancies in the offices of the President, the Vice-Presidents, and the Treasurer and in the Executive Board and among the representatives on the American Engineering Council shall be filled as soon as feasible by the agencies originally selecting the incumbents. The officers and representatives thus chosen shall serve for the unexpired terms.

ARTICLE VI. FUNDS

Section 1. Funds for the use of the organization shall be contributed as follows:

(*a*) Each national Member-Society shall contribute annually one dollar and fifty cents ($1.50) per member

(*b*) Each local, state and regional organization and affiliation Member-Society shall contribute annually one dollar ($1.00) per member. No portion of such funds shall be applied to the use of local affiliations or state councils.

Section 2. The American Engineering Council may receive and administer gifts, bequests or other contributions for carrying out the purposes of the organization.

ARTICLE VII. LOCAL AFFILIATIONS

Section 1. *Object.* The American Engineering Council shall encourage the formation of local affiliations to consider matters of local public welfare with which the engineering and allied technical professions are concerned, as well as other matters of common interest to these professions, in order that there may be united action and that suggestions and advice may be offered to the Council.

Section 2. *Constitution.* Each local affiliation desiring membership in this organization shall submit its constitution and by-laws, and all subsequent amendments thereof, to the Executive Board of the Council for the approval of such portion or portions thereof as may affect its eligibility or its relation to the work of the Council.

ARTICLE VIII. STATE COUNCILS

Section 1. *Object.* State councils, consisting of representatives of local affiliations within the state or otherwise representative of the majority of engineers and members of allied technical professions in the state, if members of this organization, shall consider state matters of public welfare with which the engineering and allied technical professions are concerned, as well as other matters of common interest to these professions, in order that there may be united action in state affairs.

Section 2. *Constitution.* Each state council desiring membership in this organization shall submit its constitution and by-laws, and all subsequent modifications thereof, to the Executive Board of the American Engineering Council for the approval of such portion or portions thereof as may affect its eligibility or its relation to the work of the Council.

ARTICLE IX. DELIMITATION OF AUTHORITY

Local organizations and affiliations, state organizations and councils, if members of this organization, and the American Engineering Council shall deal with local, state, and national matters, respectively, and shall be autonomous with respect thereto. It shall, however, be the duty of the American Engineering Council to interest itself in the activities of local and regional organizations and affiliations and state organizations and councils if such activities are of national scope, or affect the general interest of the engineering and allied technical professions; provided, that nothing herein stated shall be construed as preventing the discussion by any local and regional organization and affiliation or state organization and council or by the American Engineering Council of any matters of interest to engineers and members of allied technical professions, or action by that Council on local or state matters where there is no local or regional organization or affiliation or state organization or council.

ARTICLE X. PUBLICITY

This organization shall stand for the principle of publicity and open meetings, under such provisions as may be provided in the By-Laws.

ARTICLE XI. AMENDMENTS

Section 1. An amendment to this constitution may be proposed by the Executive Board.

Section 2. An amendment may be proposed, in writing, by at least twenty-five representatives on the American Engineering Council. Such amendment shall be considered first by the Executive Board, which shall report on it to the Council, approving or disapproving or modifying it or submitting an alternative amendment. This report shall be accompanied by the original proposed amendment.

Section 3. An amendment proposed as provided in Sections 1 and 2 shall be considered at a meeting of the Council after it has been submitted to its members at least ninety days in advance of the meeting. At such meeting, provided a majority of the representatives be present, the amendment may be rejected, or otherwise submitted to the members of the Council for letter ballot within thirty days thereafter, with such modifications as may be adopted by a majority of those present. The amendment shall require a two-thirds affirmative vote for its adoption.

By-Laws

CHAPTER I. MEMBERSHIP

Section 1. *Qualifications.* Any society or organization of the engineering or allied technical professions whose chief object is the advancement of the knowledge and practice of engineering or the application of allied sciences and which is not organized for commercial purposes is eligible for membership.

Section 2. *Admission.* The Executive Board shall submit to a letter ballot of the American Engineering Council, each application for membership made to it on a prescribed form, accompanied by a statement of its findings as to eligibility and the number of representatives to which the applicant would be entitled. The applicant shall be admitted by a majority vote of the Council, provided, that not more than twenty-five per cent of the members of the Council shall vote in the negative.

Section 3. *Termination of Membership.* 1. Any Member-Society may terminate its membership on June 30 or December 31 of any year after giving at least three months previous written notice to the Secretary of its intention thereof, provided, however, that the financial obligations of such organization are discharged to the said June 30 or December 31, respectively.

2. On complaint brought by any three members of the Council, and transmitted in writing to the Secretary giving reasons why the membership of any Member-Society should be terminated, the Committee on Membership and Representation of the Executive Board shall investigate said complaint, inform itself of all matters pertaining thereto, and report its findings to the Executive Board, which may either dismiss the proceedings or make recommendations to the Council. The Council, by a two-thirds vote of those present at a meeting, may dismiss the proceedings or order a letter-ballot.

3. A two-thirds affirmative vote shall terminate membership.

CHAPTER II. MANAGEMENT

Section 1. *Terms of Representatives.* Representatives on the American Engineering Council shall serve for two years; provided, that after the first election, if there is more than one representative from one organization, approximately one-half the number of the representatives shall be elected each year.

Section 2. *Announcement of Representatives.* Each organization represented shall send to the Secretary of the Council on or before August 15 of each year the names of its representatives who are to serve for the term beginning January 1 of the following year.

Section 3. *Votes of Representatives.* Representatives on the Council and members of the Executive Board shall each have one vote in meetings of these bodies.

Section 4. 1. *Meetings.* At all regular meetings of the Council the order of business shall be as follows:

(*a*) Roll call of representatives
(*b*) Approval of minutes of previous meeting
(*c*) Report of Secretary
(*d*) Report of Treasurer
(*e*) Report of President
(*f*) Report of Executive Board
(*g*) Report of committees
(*h*) Unfinished business
(*i*) Special business
(*j*) New business.

2. *Rules of Order.* Unless otherwise provided, Robert's Rules of Order shall govern the proceedings of all meetings of the Council.

3. *Quorum.* A majority of all the representatives on the Council shall constitute a quorum at any of its meetings.

Section 5. *Nomination and Election of Officers.* 1. The Secretary shall send to each member of the Council at least ninety days in advance of the Annual Meeting, nomination blanks for offices to be filled at that meeting. Nominations received within thirty days shall be canvassed by the tellers appointed by the Executive Board and reported by them to the Board. The Board shall place upon the ballot the names of the three candidates receiving the highest number of votes.

2. The Secretary shall mail to each member of the Council, at least thirty days before the Annual Meeting, the ballot containing the names of the above selected nominees for each office.

3. Ballots received before 7 a. m. of the first day of the Annual Meeting shall be canvassed by tellers appointed by the Executive Board, and the result shall be certified to the President of the Council, who shall announce the result of the election at the Annual Meeting. A plurality of votes shall elect; in case of a tie vote the Annual Meeting shall immediately select by ballot one of the two candidates.

Section 6. *Duties of Officers.* 1. The terms of all officers elected at an Annual Meeting of the Council shall commence on the adjournment of that meeting.

2. The officers shall have the usual duties pertaining to their respective offices except as may otherwise be provided in the Constitution and By-Laws.

3. It shall be the duty of the President to represent the Council on any formal occasion.

4. The Vice-Presidents in the order of their seniority of election and age shall, in the absence or disability of the President, discharge his duties.

5. The Treasurer shall receive all moneys and shall deposit them in the name of the Council with a bank or trust company approved by the Executive Board. He shall invest all funds not needed for current disbursements as ordered by the Executive Board. He shall pay all bills covering expenditures authorized by the budget or the Executive Board, by checks countersigned by the Chairman of the Finance Committee or some other member thereof. He shall make an annual report and such other reports as may be prescribed by the Executive

Board. He shall give a bond at the expense of the Council, in amount and with surety satisfactory to the Executive Board.

6. The Executive Officer shall be appointed and his compensation fixed annually by the Executive Board and he shall hold office during its pleasure. He shall be the Secretary of the Council and of its Executive Board. He shall manage the business of the Council under the direction of the Executive Board and shall perform such duties as may be assigned to him by the Council or the Executive Board. He shall be the custodian of the property of the Council. He shall collect all moneys due the Council and transfer them to the custody of the Treasurer. He shall scrutinize all expenditures and use his best endeavors to secure economy in the administration of the business of the Council. He shall certify to the accuracy of all bills or vouchers on which money is to be paid. He shall give a bond at the expense of the Council in amount and with surety satisfactory to the Board. He shall pay the current expenses of the office, and for this purpose he shall have at his disposal a suitable sum of money to be fixed by the Board, which amount shall be periodically replenished under the authority of the Finance Committee upon the presentation of an account of disbursements in the form required by it. He shall mail to the Member-Societies bills for their annual contribution thirty days prior to the beginning of the fiscal year. He shall perform such other duties as may from time to time be assigned to him by the Council or the Executive Board.

SECTION 7. *Selection of Executive Board.* 1. The Secretary shall submit to the Executive Board, at its September meeting, a list of Member-Societies in good standing with their respective memberships.

2. The Executive Board shall thereupon determine the number of its members for the next ensuing administration year to be selected by national societies, and by the representatives of the local, state, and regional organizations and affiliations, as provided in the Constitution, and it shall prescribe the boundaries of the districts from which the representatives of the local, state, and regional organizations and affiliations are to be selected.

3. The Secretary, within two weeks after the September meeting of the Executive Board, shall mail to the proper officer of each Member-Society a copy of his report on membership and a statement of the Board's action with respect to the membership of the Board, and its delimitation of districts.

4. Members of the Executive Board representing national societies shall be selected by the said societies in such manner as they may determine; the secretary shall be advised of this selection.

5. Members of the Executive Board representing local, state, and regional organizations and affiliations shall be nominated and elected from each of the several districts by the representatives therefrom on the Council, at a meeting duly called for the purpose, provided, three-fourths of all representatives of said district are present or represented; the selection shall be reported to the Secretary.

SECTION 8. *Attendance at Meetings.* If any member of the Executive Board or any of its committees shall fail to attend the meetings of said Board or committee for a period of five consecutive months, not including July and August, he shall cease to be a member of said Executive Board or committee. The vacancy thus created shall be filled as provided for in the Constitution in Article V. on Unexpired Terms.

SECTION 9. *Duties of Executive Board.* 1. The Executive Board shall organize within thirty days after the adjournment of the Annual Meeting of the Council.

2. It shall hold regular monthly meetings except during July and August. Regular meetings shall be held on the second Monday of each month except that a regular monthly meeting shall be held in connection with the meeting of the Council.

3. Special meetings may be called at the discretion of the President and shall be called at the written request of five members of the Executive Board.

4. The Secretary shall mail the notices of each regular meeting at least fifteen days in advance thereof and shall mail notices of each special meeting, stating its purpose, at least ten days or shall telegraph them at least six days in advance, to each member of the Board. No business other than that for which it has been called shall be transacted at a special meeting.

5. A quorum for all meetings of the Executive Board shall be fifteen members.

6. The Executive Board, unless otherwise provided, shall appoint all special committees of the Council and of the Executive Board. The membership of such committees may be drawn from the membership of the Council or of the Member-Societies.

7. The Executive Board shall, whenever practicable, provide for the whole or a part of the expenses of members or of representatives attending its own meetings and those of the Council.

SECTION 10. *Appointment of Committees.* The following committees shall be appointed from the membership of the Board annually by the incoming President with the approval of the Executive Board, each member to serve one year or until his successor is appointed:

(*a*) On Procedure
(*b*) On Constitution and By-Laws
(*c*) On Publicity and Publications
(*d*) On Membership and Representation
(*e*) On Finance
(*f*) On Public Affairs.

SECTION 11. *Duties of Committees.* 1. The Committee on Procedure shall act for the Executive Board in the interim between its meetings, and shall perform such other duties as may be assigned to it.

2. The Committee on Constitution and By-Laws shall report on all proposed amendments, with any modifications thereof it may deem desirable, referred to it by the Executive Board.

3. The Committee on Publicity and Publications shall, when so requested, prepare all public statements and shall have the direction of publications of the Council.

4. The Committee on Membership and Representation shall report to the Executive Board on the eligibility of each applicant for membership and the number of representatives to which it would be entitled. It shall review and report at least ninety days before each regular meeting of the Council the number of representatives to which each Member-Society is entitled. It shall review the existing electoral districts and report thereon to the Executive Board, at least once every two years. It shall report on all questions regarding registration and credentials of the representatives on the Council.

5. The Finance Committee shall have supervision of the finances of the organization. It shall report an annual budget to the Executive Board at least sixty days prior to the end of each fiscal year. The Chairman or some other member of the Committee shall countersign all checks for the payment of money.

6. The Committee on Public Affairs shall report to the Executive Board on all public affairs with which the engineer is concerned or which affect the relation of the engineer to the public.

7. Special committees shall report to the Executive Board.

CHAPTER III. FUNDS

SECTION 1. *Fiscal Year.* 1. The fiscal year shall begin on January 1 of each year.

2. The contributions of each Member-Society shall be payable in advance in semi-annual payments, on January 1 and July 1 of each year, and shall be based upon a certified statement of its membership as of January 1.

3. A Member-Society failing to pay its semi-annual contribution within six months after it is due shall be suspended or dropped from membership at the discretion of the Executive Board.

4. Funds shall be disbursed, as authorized by the budget or the Executive Board, by checks signed by the Treasurer and countersigned by the Chairman of the Finance Committee or some other member thereof.

CHAPTER IV. PUBLICITY

SECTION 1. The privilege of attendance at all meetings of the American Engineering Council, of the Executive Board, and of Committees, when not in executive session, shall be extended to any proper person, but this privilege does not include the right to speak or vote. Any proper person shall have the right to inspect and make true copies of the official records of all meetings of the Council, the Executive Board, and Committees.

SECTION. 2. The Committee on Publicity and Publications may employ a Publicity Secretary whose duty under the direction of the Executive Board, shall be to prepare and supply to the engineering, technical, and general press information concerning The Federated American Engineering Societies, or the engineering world, and to coöperate with the editors of engineering and technical publications in disseminating information in regard to the organization and its activities. This Committee may appoint a coöperating board of engineering editors to counsel and assist in any or all of its activities.

CHAPTER V. AMENDMENTS

SECTION 1. An amendment to these By-Laws may be proposed by a representative on the American Engineering Council or by a member of the Executive Board. The Executive Board shall consider all proposed amendments and mail a copy of such amendments together with its report thereon to each representative on the Council at least sixty days prior to the date of a regular meeting.

SECTION 2. These By-Laws may be amended by an affirmative two-thirds vote of all representatives on the Council present at a regular meeting thereof, provided, that the proposed amendment shall have been mailed to each representative at least thirty days in advance of such meeting.

SECTION 3. Sections 2, 4 (paragraph 1), 5, 6 (paragraphs 3, 4, 5 and 6), 7, and 10, of Chapter II, of these By-Laws, and any By-Law adopted subsequent to ——————— may be amended by a vote of three-fourths of the members of the Executive Board at any regular meeting; provided, that the proposed amendment shall have been presented in writing at a regular meeting of the Board, and transmitted to each member of the Council at least thirty days previous to the date of its adoption.

Engineering and Industrial Standardization

A Review of Standardization Work Now in Progress, Both in This Country and Abroad, as Reported by the American Engineering Standards Committee and Foreign Standardizing Bodies

STANDARDIZATION in all its various phases is now receiving, both in this country and abroad, the closest study, and through the coöperative efforts of engineering societies and associations is rapidly being brought to the point where duplication of effort and the promulgation of conflicting standards will be largely avoided.

The American Engineering Standards Committee which is directing the standardization work in the United States is now engaged with the development of a great variety of standards for engineering and industry. The history of the committee will be found in Mechanical Engineering for July 1919 (p. 638), and it is thus sufficient to state at this time that while the original committee was composed only of representatives of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers, The American Society of Mechanical Engineers, the American Society for Testing Materials, and the Government departments of War, Navy, and Commerce. Later the constitution was changed so as to permit of the election to membership of other bodies interested and taking part in standardization work. Under this revised constitution five additional bodies have been admitted, thus making a total of 13 organizations now participating in the work of the Committee. These are:

1 Fire-Protection Group, composed of
    National Fire Protection Association
    National Board of Fire Underwriters
    Associated Factory Mutual Fire Insurance Companies.
2 National Electric Light Association
3 National Safety Council
4 Society of Automotive Engineers
5 Electrical Manufacturers' Council, composed of Electric Power Club
    Associated Manufacturers of Electrical Supplies
    Electrical Manufacturers' Club.

Standardization Work in the United States

By the creation of the American Engineering Standards Committee the joint action of the above-mentioned organizations along the lines of standardization has been greatly facilitated and the formulation of standards in many fields has been made possible. Under its rules the Committee selects the sponsor or joint sponsors for a given standard, who in turn organize the Sectional Committee which develops the standard. For example, The American Society of Mechanical Engineers and the American Gas Association were selected as sponsors for the standardization of pipe threads. Another society, The American Society for Testing Materials, was made sponsor for standards dealing with tests for portland cement and specifications for fire tests for materials and construction.

This spring the Sectional Committee on Structural Shapes for Ships was organized by the American Steel Manufacturers, The American Society of Mechanical Engineers and the American Society of Naval Architects and Marine Engineers acting as sponsors. The American Bureau of Shipping and the United States Navy are also represented on this Sectional Committee and real progress has been made.

Another subject receiving the attention of the Committee is that of the standardization of shafting. The American Society of Mechanical Engineers has been asked to become sponsor for this work since the Society has already done a considerable amount of work on a set of standard diameters for transmission and machinery shafting. It is proposed that the work when carried on by the Sectional Committee shall be broadened to include the standardization of the method of determining what diameters of transmission shafting should be used for given loads, the dimensions of shafting keys and keyways, and the setting of dimensional tolerances.

Coöperation With Foreign Countries

The American Engineering Standards Committee is also seeking to coöperate with similar organizations in Great Britain, France, Switzerland, Belgium and Holland. The Swiss, for example, have requested coöperation on Standards for Ball Bearings, and the formation of a Sectional Committee is now under way. Sectional Committees for Screw Threads and Cylindrical Limit Gages have also been formed. These Committees will act in coöperation with British Committees dealing with the same subject although so far as screw threads are concerned the American Engineering Standards Committee has a satisfactory understanding with National Screw Thread Commission, an abstract of whose latest report was published in Mechanical Engineering for June (p. 337). The British have also asked for coöperation on Standards for Gears, and The American Society of Mechanical Engineers and the American Gear Manufacturers Association have accepted sponsorship for this work.

Another request has come from The Swiss Standards Association, who have addressed a communication to the American Engineering Standards Committee, proposing the international standardization of the widths across flats on nuts and bolt heads. The proposal covers the range of ¼ in. (6mm.) to 3 in. (80mm.) diameter of bolts. The numerical values proposed are a compromise between the United States Standard, the British or Whitworth, and the metric "Systeme Internationale."

Standardization Organizations Abroad

In the accomplishment of such international standardization as is mentioned above foreign standardizing bodies will play an important part, and in order that the American Engineering Standards Committee might intelligently work with these foreign associations, its Secretary, Dr. Paul G. Agnew, during a recent trip to England and the continent secured information regarding the attitude of European countries toward international standardization and the means they possessed for bringing it to pass. In his report of his trip Dr. Agnew described the forms of standardizing organizations existing in Belgium, France, the Netherlands and England. Brief abstracts of these descriptions follow.

Association Belce de Standardisation

This association was organized and began work in 1919. It was organized by the Comité Central Industriel de Belgium with the support of the national engineering societies and industrial associations. The Comité Central, upon which 80 associations are represented, is a strong organization which is playing an important role in the reconstruction of Belgian industry.

There are 37 members of the main committee, 4 representing the Comité Central, 13 representing the national engineering societies, and 20 representing various industrial associations. The latter cover a wide field, among them being the chemical, paper and cotton industries. The government is not represented on the main committee, but is represented on the working committees.

The Belgian association has no arrangement corresponding to sponsorships, the actual standardization being carried out under the general direction of the main committee, and the detailed administration is handled by the central office. Members of the working committees represent the organizations interested in the particular subject in hand, and are named by the organizations. The usual size of these committees is from 10 to 15.

Owing to the industrial position of Belgium, and its commercial relations to other countries, they are planning to make, and in their work so far have made, extensive use of the standardization work of other countries, making such modifications as will adapt it to their needs. Comprised in the work already carried out are a standard series of bolts and rivets. Work now in hand includes reinforced concrete, mechanical power transmission (pulleys, bearings, etc.), water-pipe fittings, specifications for steel bridges, economics in coal consumption, and steel sections. The secretary of the Association is M. Gustave Gerard.

COMMISSION PERMANENT DE STANDARDISATION (FRANCE)

The French Commission differs from other national standardizing bodies in that it is strictly an official organization, and supported wholly by government funds. It was established by decree of the President of the Republic in June 1918. It is attached to the Ministry of Commerce, Industry, Posts and Telegraphs, Maritime Transport and the Merchant Marine. The Commission itself, which performs much the same functions as our Main Committee, has 24 members, 9 representing various government departments, one representing the Academy of Sciences, and the remainder, national engineering and industrial bodies. Officially, they are appointed by the Minister of Commerce, but they are nominated by the organizations which they represent.

The actual technical work is in charge of 14 committees covering such subjects as: Specifications for metal products; specifications for materials of construction; railways and tramways; machine elements; metallurgy; textiles; heat engines and hydraulic turbines, and materials for the chemical industry.

Special provision was made in the decree establishing the Commission for the coöperation of the government departments in the preparation of specifications, and the subsequent use of the specifications by the departments, but not in such a way as to hamper the departments by restrictions which are too ironclad. The matter is receiving further study in order to enlist the coöperation and support of the many officials in the departments.

The regular procedure is for a committee to submit a tentative specification to the Commission, and the central office submits it to all interested bodies for criticism, (societies, industrial syndicates, government departments, etc.), and the technical press is advised of the matter. The criticisms are digested by the central office, and decisions reached by the committee for final approval of the Commission.

HOOFDCOMMISSIE VOOR DE NORMALISATIE IN NEDERLAND

The "Main Committee for Standardization in the Netherlands" was organized in 1916, by the Society for the Encouragement of Industry and the Royal Institute of Engineers. Each of these societies names two members of the Main Committee, the total membership of which is 15. The other 11 members are designated by the Committee itself, the term being 3 years. The president, vice-president and treasurer form a small executive committee which meets frequently. There are four regular meetings of the Main Committee a year. As in the case of Belgium, the relatively small size of the country and its industrial and commercial position necessarily affect their standardization work.

Industrial associations (syndicates) do not seem to be very largely developed in Holland. Often there are not more than three or four concerns in an industry. It would appear that these facts have had an influence on the methods adopted in handling the appointment of working committees, etc. When a member of the Main Committee has the necessary qualifications for the chairmanship of a working committee, he is chosen for it. The other members of the standing committees are chosen by the Main Committee.

The central office does a much larger part of the technical work of standardization than is the case with the other national standardizing bodies. The office opened in July, 1918. There are a total of 16 on the staff. There are two technically trained engineers besides the secretary, one electrical and one mechanical, and it is planned to add a civil engineer and a marine architect in the immediate future. There is a drafting room with an experienced man at the head. A very complete information service is maintained on the various phases of engineering standardization. An elaborate index system covers not only formally published standards, but also technical articles bearing on subjects in which standardization work is going on, or in which it is considered likely that such work will be undertaken. Mr. E. Hymans is the secretary.

The office prepares the material for all committee meetings. In taking up a new subject, for example, all available standards and proposals, both in Holland and in other countries, are shown in comparative tabular or graphic form. But the office goes farther and draws up what may seem to it as a reasonable proposal for the consideration of the committee. Of course, the office has no voice in decisions, and is not to attempt to influence decisions.

The form of publication is unique. Standards are issued as single sheets, perforated for binding in loose-leaf folders. The essential information is given in compact form, any necessary explanatory notes being given on the back of the sheet. The general style is that of a working drawing, and the idea is that they shall be issued directly to the draughtsman in the plant. They are lithographed from drawings, and printed on special paper that does not soil. The price is 15 Dutch cents ($0.06) per sheet. New sheets are being issued at the rate of about one per week.

BRITISH ENGINEERING STANDARDS ASSOCIATION

The British Engineering Standards Committee was organized in 1901 by five leading technical societies. It was incorporated in 1918, and the name changed to Association. The general direction of affairs is in the hands of the Main Committee, which constitutes the sole executive authority. There are 24 members, 19 of whom are appointed by the technical societies and the remaining 5 are chosen by the appointed members, two being from the Federation of British Industries.

Sectional committees are responsible for the technical work in different subjects. Working under the sectional committees are subcommittees, which handle smaller subdivisions of the work. Still smaller subdivisions are handled by small committees termed panel committees, or briefly, panels, to avoid the use of the word subcommittee. Most of the detailed work is done in the panels. There are some 275 of these committees, with 1370 members in all. The members of all the different committees constitute the membership of the Association. A general meeting of the Association is held once a year. The government is represented on most of the working committees, but not upon the Main Committee. There are now 40 on the staff of the central office.

The steps in setting up a committee for a new project are as follows: A request must first come either from an association or a government department. A conference is then called at which all interests to be affected by the proposed work are represented. The purpose of the conference, which is presided over by the chairman of the Association, is to determine whether standardization is to be undertaken. In case the decision is that it shall be undertaken, the chairman of the sectional committee is named by the Main Committee. The members of the Sectional Committee are designated by organizations directly interested in the work of the committee. Generally the members so designated add a very few men of recognized standing to complete the committee.

Great stress is laid by the British upon this procedure which has been evolved as the result of 19 years' experience. They feel that wherever there are responsible industrial associations, it is emphatically best to deal with the industry through the association, and to have the members of the sectional committees appointed by the associations, rather than to have them "hand-picked" by a central body. The addition of a few men by the members who are representatives, makes it possible to obtain the services of outstanding men whose services would not otherwise be secured. The financial support of the Association comes from a variety of sources. In the last year contributions were received from 7 government departments, 47 municipalities, 34 railways, 18 industrial associations, and 98 individual firms.

During the war the government requested the Association to take over the formulation of specifications for aircraft material, and this is being continued. Official governmental representation on the International Aircraft Standards Commission is essentially the same as that in the organization created by the Association for standardization in the domestic industry. A similar arrangement exists in the case of the national committee of the International Electrotechnical Commission. A recent development of the Association has been in the field of shipbuilding. There are two sub-committees—one on ships' fittings and one on machinery. An unusual feature of this work is that there is a geographical division between the Tyne and the Clyde, the work being carried on largely independently in the two regions. Perhaps the most important work in this line is the agreement which has been reached upon standard tail shafts.

INTERNATIONAL STANDARDIZATION

In concluding his report Dr. Agnew briefly touched upon the question of international standardization. "One heard a great deal of the necessity of international agreement in various lines of engineering result," he writes. "A suggestion has been made by the Swedish organization that there should be a regular publication in which the work of the projects under way in the different organizations could be abstracted. On the continent there has been some discussion of the desirability of a general international organization, modeled somewhat after the national organizations. While some steps have been taken in this direction, there seems to be a general opinion that such an organization would be unwieldy and liable to fall of its own weight. The reason for this view is that in most, if not in all countries, national standardizing organizations are not yet sufficiently developed, and industry itself is not sufficiently well organized, to permit of a general international engineering standards organization. A much less formal approach to the problem, consisting merely of an informal conference of the secretaries of the various national organizations, seems to have received considerable discussion. This last was favorably considered in a meeting of the Main Committee of the British Association, and it is probable that informal inquiries will be addressed to the various national bodies to determine what their attitude might be toward such an undertaking."

NEWS OF THE ENGINEERING SOCIETIES

American Drop Forge Association and American Society for Testing Materials Hold Annual Meetings—Society of Automotive Engineers Meet in Semi-Annual Convention

American Drop Forge Association

TECHNICAL papers on accident prevention, standardization, company stores, pulverized coal and the lubrication of the steam drop hammer, were presented at the annual meeting of the American Drop Forge Association, held at Atlantic City, N. J., June 17, 18 and 19.

Accident prevention with special reference to forge shops was discussed by G. A. Kuechenmeister, Dominion Forge and Stamping Co., Walkerville, Ont., who described scale and treadle guards in use by the Dominion company, explaining how the use of a sweat pad in connection with goggles had been a factor in getting the goggles used, and outlined means for stimulating the interest and enlisting the coöperation of all employees in safety work.

A paper on the standardization of die blocks was read by C. B. Porter, president of the Sizer Forge Co., Buffalo, and chairman of the standardization committee of Forgemen's Exchange. Standardization of sizes of blocks into the fewest number of sections and lengths, he explained, would facilitate prompt deliveries more than any other factor, because it would allow orders from several customers to be combined and made in lots. He suggested that the users make up a list of standard sections with a few standard lengths for each section. The maker could then easily determine the percentage of replacements that usually occur in each grade and size of block and could add the proper number of stock order blocks to each lot order to compensate for any rejections, and any spares that would thus be made in excess of the order could be immediately applied to future loss. The sizes of blocks, steel in blocks, method of forging, annealing and hardening treatment, were also taken up in detail by Mr. Porter.

The operation of the stores department of Cleveland Hardware Co. was described by Edgar E. Adams. Every month a statement is rendered to each foreman showing how much in dollars the supplies used in his department have cost. When this policy was first established it had little effect, but soon the different foremen began to compare amounts they were paying for supplies and a saving began to be noticed. In time the expense of shop supplies was cut down fully 50 per cent.

C. F. Herington, Bonnot Co., Canton, Ohio, quoted comparative cost figures of burning oil fuel and pulverized coal. One company operating ten stills has been spending $18,000 per month for fuel oil. They are about to install a pulverized-coal plant and expect to make with it a saving of $130,000 per year. The cost of the plant completely erected is to be $85,000, so that they will save that cost in about nine months.

Answering an inquiry as to what the minimum daily consumption of fuel oil would be that it would pay to convert to pulverized coal, Mr. Herington said that about 3000 gal. In such case, he added, with present prices of oil, the pulverized-coal plant would pay for itself in less than a year.

The problem of supplying the proper amount of lubricant to the steam drop hammer was discussed by Harry Johnson, Ingalls-Shepard Forging Co., Harvey, Ill. The success attained with any lubricating system in connection with steam cylinders, he remarked, depends on the layout of the steam line and the method employed in draining. In a test conducted on a 12,000-lb. steam drop hammer with the object of obtaining an oil that would lubricate it economically and would leave exhaust steam sufficiently clean for heating purposes, best results were obtained with a product composed of a full filtered cylinder stock compounded with an acidless tallow oil.

An arrangement of a 2-qt. four-feed motor-driven mechanical lubricator used for supplying this oil was described by Mr. Johnson. The oil was discharged into the steam through a siphon atomizer. One drop of oil per minute was supplied for each 2 sq. ft. of wearing surface involved in the circular area of the cylinder and in that portion of the piston rod that passed through the piston-rod packing.

American Society for Testing Materials

The annual meeting of the American Society for Testing Materials was held at Asbury Park, N. J., on June 22-25. The committee on steel, A-1, proposed new tentative specifications for commercial bar steels, covering ordinary commercial carbon bar steels, rounds, squares and hexagons of all sizes, and flats not over 6 in. wide and hot-rolled or cold-finished. The classification is as follows:

GRADES AND CHEMICAL COMPOSITION OF BAR STEELS

Grades	Carbon, per cent	Manganese, per cent	Phosphorus, per cent	Sulphur, per cent
Open-hearth:				
Dead soft	0.05-0.12	0.55 max.	0.05 max.	0.06 max.
Soft	0.08-0.18	0.55 max.	0.05 max.	0.06 max.
15-25 carbon	0.15-0.25	0.60 max.	0.05 max.	0.06 max.
20-30 carbon	0.20–0.30	0.70 max.	0.05 max.	0.06 max.
25-40 carbon	0.25-0.40	0.70 max.	0.05 max.	0.06 max.
35-50 carbon	0.35–0.50	0.70 max.	0.05 max.	0.06 max.
Bessemer:				
Welding	0.12 and under	0.60 max.	0.115 max.	0.08 max.
Soft	0.15 and under	0.70 max.	0.115 max.	....
15-25 carbon	0.15–0.25	0.90 max.	0.115 max.	....
25-40 carbon	0.25–0.40	0.90 max.	0.115 max.	....
35-50 carbon	0.35–0.50	0.90 max.	0.115 max.	....
40-60 carbon	0.40-0.60	1.00 max.	0.115 max.	....
Screw Steel:				
Bessemer screw	0.08–0.16	0.60–0.80	0.09–0.13	0.075-0.15
Open-hearth screw	0.15–0.25	0.60–0.90	0.06 max.	0.075–0.15

At the 1919 meeting, by recommendation of committee A-1, the note which had been added to 43 specifications by action of the Society in 1918, raising the rejection limits for sulphur in all steels and for phosphorus in acid steels 0.01 per cent above the values given in the specifications, was removed from 29 of those specifications, and with respect to the remaining 14 specifications consideration of the removal was deferred until the meeting in 1920. Acting on an agreement that open conditions still obtain, the committee recommended that the removal of the note be again deferred until the meeting of 1921.

The other recommendations of the committee were largely revisions to established and tentative specifications.

Among the technical papers were those dealing with the following subjects: A new method for testing galvanized coatings, offered by Dr. Allerton S. Cushman, president Institute of Industrial Research, Washington; a description of the processes of manufacture, heat treatment and physical properties of large power-forged chain as made at the Boston Navy Yard, presented by Carlton G. Lutts, physical metallurigist of the hull division at the Boston yard; suggestions for more intensive investigations in delimiting the scope and kind of application for the various materials of engineering, contained in President J. A. Clapp's address; a strong brief for molybdenum as an alloying element in structural steel, presented by G. W. Sargent, and a discussion on so-called shattered zones in steel rails by Dr. J. E. Howard, engineer-physicist Interstate Commerce Commission, Washington.

Society of Automotive Engineers

The Society of Automotive Engineers held its semi-annual convention on June 21-25 at Ottawa Beach, Mich.

At the fuel session Dr. W. S. James presented the findings of the Bureau of Standards on intake-manifold experiments. The program of the work, which was undertaken by the Bureau at the request of the committee of the society on utilization of present fuels in present engines, included measurements of engine performance under conditions of both steady running and rapid acceleration with different temperatures of the intake charge secured by three different methods: (*a*) the hot-air stove supplying heated air to the carburetor; (*b*) the uniformly heated intake manifold; and (*c*) the "hot-spot" manifold. Fuel economy was determined for both part and full-throttle operation. The engine which was used was of modern six-cylinder automobile design.

A preliminary series of runs was made with an intake manifold having the tee section of Pyrex glass and motion pictures were taken of the phenomena observed. In but one of the runs the inside walls were completely dry, and this condition was attained only with great difficulty by the direct application of the flames from two blazing torches to the glass tee. The greatest amount of liquid was present in the manifold at 650 r.p.m. and full throttle, the layer being at least 1-16 in. deep in some places. The liquid collected mainly on the lower side of the manifold between the tee and the intake parts.

The main series of runs was made with an exhaust-jacketed intake manifold. Fuel consumption tests were conducted at both full and half load at speeds of 650 and 1200 r.p.m. These conditions were selected as covering the range of average driving from 15 to 25 m.p.h. Acceleration runs were made for which a dynamometer load was selected to correspond with that of a car at about 45 m.p.h. with full throttle. The results thus far obtained were summarized by Mr. James as follows:

1 At constant speed, mixture ratio, and power outputs, the fuel consumption in pounds per brake-horsepower-hour is independent of the temperatures and methods of heating the intake charge within the range tested.

2 The rate at which an engine will accelerate with a given mixture ratio, or carburetor setting, is markedly affected by the amount of heat supplied and its method of application. Within the limits of this work the greater the amount of heat supplied to the charge and the higher its temperature at the intake port the more rapidly the engine will accelerate.

Another speaker at the fuel session was O. H. Ensign, president Ensign Carburetor Co., Los Angeles, Cal., who described a carburetor that has been in use for the last five years on the Pacific Coast, and was designed to handle an intermediate grade of petroleum distillate, known as engine distillate, which has there been supplied to users of motor vehicles. The principle involved for metering the fuel and air is the drop in pressure that occurs at the center of a whirling mass. The suction air whirls in a special chamber at the center of which terminates a pipe connecting with a cylinder provided with small orifices and surrounded by the fuel. The decrease in pressure or suction at the center of the whirl draws fuel through the various passages into the whirl chamber where it thoroughly mixes with rotating air. The device, Mr. Ensign explained, is permanent in its performance and high in fuel economy.

A symposium on engine design was also presented at the fuel session. It consisted of the following papers: Notes on the Use of Heavy Fuel in Automotive Engines, by H. M. Crane; Engine Design for Maximum Power and Economy of Fuel, by C. A. Norman; Saving Fuel with the Carburetor, by W. E. Lay; and Some of the Factors Involved in Fuel Utilization, by P. S. Tice.

That power farming offers a wide field for engineering research was emphasized by the speakers at the farm-power session. O. B. Zimmerman read a paper entitled Analysis of Fundamental Factors Affecting Tractor Design. The paper dealt chiefly with the effect of grade upon speed and drawbar pull and the effect of rolling resistance upon tractor output. Numerous graphs were included to show the variation of some of the factors with others. Referring to the amount of interesting reliable research work that can be done with advantage in the tractor and plow industry, Mr. Zimmerman said:

> When it is realized what the actual expenditure of energy each year on the United States farms really is and that the majority of it can be done by mechanical power; that a very large part of it can be performed by a properly designed tractor and that estimates of this energy expenditure show it in actual horsepower to be greater in quantity than all other energy expenditures of industry in the United States, including mines, manufacturing, lighting, etc., we must admit that every available resource of engineering skill and scientific research must be expended and quickly, to raise the tractor and implement industry to one where the most exact and careful design will be evident from every possible economic standpoint. Basic data must be established along many lines; special test equipment and apparatus must be designed and built; whole series of experiments must be carried out at various seasons and in different soils; these latter must be studied in various conditions of moisture content; plow and engine design features must be shifted and standards adopted toward which the whole industry will then be enabled to work for early sensible economic solutions in the general interest of the nation as a whole.

There were two other professional sessions, on production and on transportation. Some of the papers read at these sessions were: Production Control and Systems of Accounting, by A. C. Drefs; The Workman, an Element in Production, by A. F. Knobloch; Interdepartmental Production Contests, by R. R. Potter; Motor-Bus Transportation, by G. A. Green; and The Relation of the Motor Transport Corps to Commercial Transportation, by Col. B. F. Miller, M. T. C., U. S. A.

ALLOY STEELS IN THE AUTOMOTIVE INDUSTRY

(*Continued from page* 505)

It will be noted that in this particular test the cast cutter, while run at a slightly lower speed than the standard cutter (93 ft. per min. vs. 109 ft. per min.) took a more severe cut. It cut 4 in. at 0.69 in. per min. before failure, whereas the standard cutter failed after cutting 1.5 in. at a lower feed of 0.69 in. per min.

TABLE 9 CUTTING TEST OF CAST HIGH-SPEED STEEL MILLING CUTTER

Material	Speed, ft. per min.	Feed, in. per min.	Depth, in.	Length cut, in.	Condition of cutter
Cast iron	60	0.30	0.125	8.2	Good, slight wear
Soft steel	60	0.30	0.219	1.5	Good, slight wear
	71	0.30	0.219	2.5	Slight wear, but cutting smoothly
Rail steel	60	0.30	0.200	1.0	Good
	93	0.30	0.200	0.8	Good
	93	0.69	0.200	4.0	Good
	93	1.31	0.200	2.0	Cutter began to "go," the wear increasing. Millings "blue heat"

A high-speed steel cutter of standard make was tested on the same rail. It had previously been worn slightly, corresponding approximately to the wear resulting from the cast-iron and soft-steel cuts on the cast cutter.

Material	Speed, ft. per min.	Feed, in. per min.	Depth, in.	Length cut, in.	Condition of cutter
Rail steel	70	0.30	0.200	1.0	Good
	109	0.30	0.200	0.8	Good
	109	0.69	0.200	1.5	Cutter began to "go," one corner burning and wearing down. Millings hot but still "white"

Attention is invited to the fact that this test is not presented as being conclusive evidence that cast high-speed steel cutters are either superior or inferior to tools produced from bars or forgings, but is of interest chiefly in showing the refractory nature of the carbides in cast high-speed steel. It indicates that ordinary heat treatment is not sufficient to bring these carbides into solution, and further that good service may be obtained. Probably such tools may be applied to special lines of work.

LIBRARY NOTES AND BOOK REVIEWS

Applied Aerodynamics. By G. P. Thomson. The Norman W. Henley Publishing Co. Cloth, 7 x 10 in., 292 pp., illus., charts, diagrams, plates, $12.50.

This book is the work of a former officer in the Royal Air Force, who, during the War, was in touch with both the demands from the Front and the attempts made to fulfil those demands from home sources. The results presented are drawn from data accumulated during the War, some of which has been or will be published in the Reports of the Advisory Committee for Aeronautics, and the author has also had free access to the staff and records of the Aircraft Manufacturing Company. The work is concerned only indirectly with the mechanical side of aircraft design, but it specializes upon aerodynamics as a branch of engineering, though an account is also given of such progress as has been made on this side of physics from an engineer's point of view.

A number of suggestions for further inquiry and research are made, such as the problems relating to the interaction of aeroplane fuselages, nacelles and the airscrews attached to them. The importance of full-scale work is emphasized, and the problem of stability is dealt with at length. The question of how heavily the wings of an aeroplane should be loaded is discussed and the subject of abnormally large aeroplanes is also taken up. The information given was up-to-date at the time of writing and pains have been taken to point out the cases in which there was any considerable probability of error.

The Coal Catalog, combined with Coal Field Directory for the year 1920. Containing Explanatory Articles on Rank, Usage, Analysis, Geology, Storage and Preparation of Coals. Compiled and published annually by Keystone Consolidated Publishing Company, Pittsburgh. Cloth, 9 x 12 in., 1133 pp., illus., maps, tables, $10.

The second edition of the Coal Catalog, in addition to describing and listing the coal mines of the United States, with the output and operating companies, has added much new data such as the fusion points of ash from the various coals, the specific gravities and weights of coals and the so-called "fuel ratios." A list of national and local associations is included as well as the wholesale dealers in the larger towns and cities. A Directory section follows each state.

Direct-Current Motor and Generator Troubles, Operation and Repair. By Theodore S. Gandy and Elmer C. Schacht. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 x 8 in., 274 pp., illus., tables, $2.50.

The chief object of this book is to give simple, effective methods for finding and remedying troubles of direct-current motors and generators. In addition, the selection, operation, care and repair of direct-current machinery are analyzed from the operator's point of view. The theory underlying the design of these machines is omitted, as the book is intended for operators, not for designers.

Drainage Engineering. By Daniel William Murphy. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 x 9 in., 178 pp., illus., plates, tables, $2.50.

This is a general treatise on the drainage of agricultural lands, which indicates the various questions to be considered in connection with a drainage project, and presents the principles involved in the design and construction of drainage works. The author was formerly a drainage engineer in the U. S. Reclamation Service.

Engineering for Land Drainage. A Manual for the Reclamation of Lands Injured by Water. By Charles Gleason Elliott. Third edition, revised, John Wiley & Sons, Inc., New York, 1919. Cloth, 5 x 8 in., 363 pp., illus., maps, tables, $2.50.

This book is prepared to present the essential features of drainage engineering as practiced in this country today and is adapted to the use of professional engineers and students. This edition has been revised and enlarged. The discussion of the hydraulics of flow has been rewritten and new tables for the discharge of tile drains are given. A diagram to facilitate the use of Kütter's formula in the design of ditches and canals has been added, as well as new material.

Die Magnetische Induktion in Geschlossenen Spulen. By Arthur Scherbius. R. Oldenbourg, Münichen & Berlin, 1919. Paper, 7 x 10 in., 91 pp., illus., 7 marks.

This monograph treats of the possibilities, both theoretical and technical, of phase transformation by transformers and machines without commutators. The author discusses these possibilities with special reference to the limits within which technical applications may be possible and gives particular attention to the saturated transformer.

Manual for the Oil and Gas Industry under the Revenue Act of 1918. By Ralph Arnold, J. L. Darnell and others. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 x 9 in., 190 pp., charts, tables, $2.50.

This manual was first issued in 1919 as a bulletin by the Oil and Gas Section of the Bureau of Internal Revenue. The demand having exceeded the supply, this private reprint, in which certain features have been brought up to date, is published.

The book is intended to assist the taxpayer of the oil and gas industry in preparing his Federal tax returns correctly and expeditiously. It is divided into three parts. Part one deals directly with the law and regulations, part two with depreciation, while part three describes methods of estimating underground reserves, especially by means of production curves, a collection of which are included.

A Metallographic Study on Tungsten Steels. By Axel Hultgren. John Wiley & Sons, Inc., New York, 1900. Cloth, 6 x 9 in., 95 pp., illus., 43 plates, tables, $3.00.

As the question of tungsten steels has been studied by several investigators whose views have not always agreed, it is the purpose of this work to bring about a clearer understanding by presenting certain new facts and problems and by critically examining previous results and opinions. The subject is divided into two sections: (1) The transformations of tungsten steel during different heat treatments and the structures thereby formed; (2) Carbides in tungsten steels. Each section contains a review of the results and opinions of previous investigators and the author's own results and conclusions, based on his metallographic investigations at the Institute of Technology of Charlottenburg, the Royal Institute for Testing Materials, Stockholm, and in the Laboratory of the SKF Ball Bearing Co., Gothenburg, Sweden. The paper was written in Swedish in 1918. In its present form it includes a translation of the Swedish paper as well as an appendix containing a critical review of the investigations on tungsten steels of Honda and Murakami.

Popular Oil Geology. By Victor Ziegler. Second edition. John Wiley & Sons, Inc., New York, 1920. Flexible cloth, 5 x 7 in., 171 pp., illus., chart, maps, tables, $3.

The second edition of this work on oil geology has been partially rewritten and new material along the more theoretical lines of geology has been added. The principles important in the examination of prospective oil land have been emphasized and the work of the oil geologist described in some detail. The work is intended to make intelligible to the layman the fundamental principles of oil geology and is written in as clear and simple language as possible.

Practical Chemistry. Fundamental Facts and Applications to Modern Life. By N. Henry Black and James Bryant Conant. Macmillan Co., New York, 1920. Cloth, 5 x 8 in., 474 pp., illus., plates, $2.

It is the purpose of this book to present the fundamental facts of chemistry and to show by the application of those facts to experiences of everyday life that the subject is real and practical. The economic significance of chemistry of growing allied industries has been stressed and the chemistry of growing things has also been considered. Only such topics have been included as young people can grasp and find useful. The book is adapted for class use as a textbook.

THE ENGINEERING INDEX

(Title Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press. At the end of the year the monthly installments are combined and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents each, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Forge Shops

Accident Prevention in Forge Shops, by G. A. Kuechenmeister. Amer Drop Forger, vol. 6, no. 6, June, 1920, pp. 282-286, 4 figs. Suggests that safety departments may be organized in exactly the same manner and will be as efficient and helpful as in steel and other industries. Paper read before Am. Drop Forge Assn.

AERIAL PHOTOGRAPHY

Chart Drawing

Aerial Photography for Topographical Precision Work and Particularly for Making the Register of Real Property of a Region (La photographie Aérienne appliquée aux travaux topographiques des précision et en particulier a la réflection du cadastre). A. Guillemet. Revue générale des Sciences, vol. 31, no. 10, May 30, 1920, pp. 313-319, 3 figs. Roussilhe method of drawing charts from aerial photograph.

Geographical and Geological Research

Aircraft Photography in the Service of Science, H. Hamshaw Thomas. Nature, vol. 105, no. 2641, June 10, 1920, pp. 457-459, 3 figs. Examples of applications of aerial photography in geographical and geological research.

AERONAUTICAL INSTRUMENTS

Turn Indicator

The Pioneer Turn Indicator, Charles H. Colvin. Aviation, vol. 8, no. 7, May 1, 1920, pp. 283-284, 5 figs. Operates by force obtained from reaction of small gyroscope to turning movement of plane.

AEROPLANE ENGINES

Construction Materials

High-grade Construction Materials (Hochwertige Werkstoffe), F. Kretzschmar. Schiffbau, vol. 21, nos. 17-18 and 19-20, Mar. 17-24 and Mar. 31-Apr. 7, 1920, pp. 519-523 and 556-561, 4 figs. Notes on materials used in construction of light engines, such as those for automobiles, dirigibles and aeroplanes, giving mechanical and chemical properties of high-grade steels, of aluminum and electron metal, and their treatment during preparation.

Design

The Present-Day Problems of Aerial Propulsion (Die heutigen Probleme des Flugzeugantriebes), K. Kutzbach. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 13-14, Apr. 3, 1920, pp. 304-307, 3 figs. Discussion of the various means of reducing weight of aeroplane engines and of the fuel per hp-hr.

Hispano-Suiza

Standard Engine Report Hispano-Suiza Model "H" 300 H.P. Eng. Division Air Service. Technical Orders, no. 14, March, 1920, pp. 14-44, 21 figs. Specifications: number of cylinders, 8; stroke-bore ratio, 1.07:1; piston displacement per cylinder, 140.8 cu. in.; compression volume, 32.6 cu. in.; compression pressure, 102 lb. at 120 r.p.m.; total weight, 632 lb. Test results are included.

Ignition

Comparative Merits of Dixie Magnetos and Delso Battery Ignition System When Used on a Liberty "12" Aero Engine. Aviation, vol. 8, no. 7, May 1, 1920, pp. 291-292. Tests showed no appreciable difference in power or freedom from fouling of spark plugs. From Air Service Information Circular.

Maybach

The 260-Hp. Maybach Aeroplane and Dirigible Engines (Der 260 PS Maybach-Flug- und Luftsschiffmotor), Otto Schwager. Motorwagen, vol. 23, no. 11, Apr. 20, 1920, pp. 176-179, 4 figs. Details and illustrations of firm's newest construction types, the MB IVa for aeroplanes and the Mb IVa L for dirigibles. Curves are given showing results of tests of engines and of under-pressure chamber of a Zeppelin. (Concluded.)

Salomon

The Salomon Motor in which Fuel Charge Varies with Altitude (Le moteur Salomon á remplissage variable), M. d'About. Vie Automobile, vol. 16, no. 703, April 10, 1920, pp. 131-134, 2 figs. Motor for flying at high altitudes. Entrance of charge into cylinder is regulated by automatic spring valve, placed between carburetor and valve, which opens only when difference of pressures on both of its sides is o.3 kg. per sq. cm. At low altitudes, automatic value permits passage of only o.6 of total charge. Ratio increases with increase in altitude.

Test Engine, Universal

Universal Test Engine. Air Service Information Circular, vol. 1, no. 47, May 8, 1920, 7 pp. In this engine, it is said, cylinders can be tested which have bore diameters from 4 to 8 in. inclusive, and strokes from 4 to 8 in., inclusive.

[See also CARBURETORS.]

AEROPLANE PROPELLERS

Air-Screw Theory

A Fundamental Theorem in Airscrew Theory, A.R. Low. Aeronautics, vol. 18, no. 348, June 17, 1920, pp. 466-467, 5 figs. It is demonstrated that characteristic curve of thrust of any airscrew against singular speed for given forward speed can be transformed into corresponding curve at any other given speed.

Design

Notes on Propeller Theory and Design, Alexander Klemin. Aviation, vol. 8, no. 10, June 15, 1920, pp. 396-401, 15 figs. Based on theoretical assumptions and examinations of results of tests of various experimenters notably Durand's tests at Leland Stanford Laboratories.

AEROPLANES

Aerophysical Investigations with

Aerophysical Investigations with an Aeroplane (Aerophysikalische Forschungen mit dem Flugzeuge), Albert Wigand. Luftfahrt, no. 1-2. Jan., 1920, pp. 8-10, 6 figs. Results of tests are said to show that for recording of atmospheric-electrical charges, conditions in aeroplane are in some respects very favorable if the instruments employed are insensitive to shocks, and the Wulf double-filament electrometer is said to be well adapted thereto. For measurement of the ionization, a tube condenser with anemometer is used; for recording total energy of radiation of the sun during climb, a thermometric method, similar to the Michelson-Marten method, is recommended.

Aerofoils

Report of Wind Tunnel Test on U. S. A. Aerofoils 25, 26, 27, 28, 29. Air Service Information Circular, vol. 1, no. 49, May 12, 1920, 19 pp. 15 figs. Tables and charts are included which give ordinates K_y, K_x, L/D and center of pressure travel of each section.

The Aerodynamic Properties of Thick Aerofoils Suitable for Internal Bracing. Flight, vol. 12, no. 18, April 29, 1920, pp. 480-483, 14 figs. Effect of adding convex lower surface to thick tapered wing. (Continuation of serial.)

Two New Clark Aerofoils. Aviation, vol. 8, no. 10, June 15, 1920, pp. 394-395, 5 figs. Comparison of U. S. A. 26 and U. S. A. 27 aerofoils developed by Maj. V. E. Clark of Eng. Division, United States Air Service

Balancing

Balancing of Airplanes (Centrage des Avions), L Huguet. Vie Technique & Industrielle, vol. 1, no. 3, May, 1920, pp. 118-122, 9 figs. Technical study of relative influence of various elements of an aeroplane upon its longitudinal stability in flight. (To be continued.)

Boulton and Paul All-Metal

The Boulton and Paul P-10 All-Metal Two Seater, General Purpose Biplane. Eng. Division Air Service, Technical Orders, no. 14, March, 1920, pp. 83-86, 4 figs. Specifications: overall length, 26 ft.; wing span, 30 ft.; height, 12 ft.; weight, total, 1700 lb.; speed, fully loaded, at 1000 ft., 104 m.p.h.; climb, fully loaded to 5000 ft., 8 mon.; ceiling, 14,000 ft.

Cowling, Safety

New Safety Cowling Designed to Eliminate

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Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Injury to Face. Aerial Age, vol. 11, no. 17, July 5, 1920, p. 583, 3 figs. Original line of cowling is cut away in a U-shaped opening in front of pilot's head.

Design

Determination of Sweepback for Line-Up, T. P. Wright. Aviation, vol. 8, no. 10, June 15, 1920, p. 394, 2 figs. Formula for determining increase in stagger from wing root to wing tip.

Driving Gears

Aeroplane Driving Gears (Flugzeuggetriebe), W. G. Noack. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 15-16 and 17-18, Apr. 17 and May 1, 1920, pp. 317-322 and 346-350, 33 figs. Description of different types of drives for direct connection to engine. including noteworthy foreign designs and the so-called combined geared drive principally used for German giant planes. Notes on measurement of gears and their construction, lubrication and durability of drives, and description of the most important types of couplings for such drives. (To be concluded.)

Fabric Coverings

Experiments with Varnishing of Fabric Coverings for Aeroplanes (Versuche mit getränkten Stoffbespannungen), A. Pröll. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, nos. 1 and 2, Jan. 15 and 31, 1920, pp. 1-6 and 17-23, 25 figs. Results of experiments are said to show that the most important points to be considered are strength of material to be impregnated, flexibility and toughness of varnish coating, change in form of impregnated material and its tensile strength, permeability for air and water, recuperative strength, and durability and weight.

Simplified Curves for Fabric Coverings of Aeroplanes (Vereinfachte Kennlinien für Flügelbespannsstoffe), E. Everling. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 2, Jan. 31, 1920, pp. 23-25, 2 figs. For measurements of stretching of fabric under different stresses, in place of standard characteristics of Haas, a symmetrical method with use of curves is recommended. Special mention is made of Pröll's investigations published in previous issues of same journal. Report from German Experimental Aerial Station.

Fokker

Report of Static Test of Fokker Type D-VII Chassis. Air Service Information Circular, vol. 1, no. 29, April 2, 1920, 7 pp. 6 figs. Test to determine strength of chassis.

Junkers Two-Seated Biplane

The Junkers Armored Two-Seater Biplane, Type J. 1. Aviation, vol. 8, no. 7, May 1, 1920, pp. 285-289, 8 figs. Specifications: Engine, 230 hp. Benz.; gasoline capacity, 26 gal.; total weight, 4569 lb.; oil capacity, 10 gal.; crew, two, pilot and observer gunner; overall length, 29 ft. 8 in.; span, upper plane, 55 ft., lower plane, 35 ft. 7 in.; overall height, 11 ft. 9 in.

Laddon Night Pursuit

Report on Wind Tunnel Test of Laddon Night Pursuit Airplane. Air Service Information Circular, vol. 1, no. 33, May 5, 1920, 10 pp., 6 figs. Object of test was to determine best stabilizer setting for normal setting of wings with no decalage, and to determine effect on gliding angle and on stability of varying angle of lower wing relative to upper wing with stabilizer constant at 1 deg. to upper wing chord.

Landing Chassis

Report of Static Test of the Landing Chassis of DH-4-P-34. Air Service Information Circular, vol. 1, no. 38. May 8, 1920, 8 pp. 5 figs. Axle of chassis is one continuous piece of steel tubing. Shock absorbers consist of four units of eight loops each and are made of 9/16-in. elastic cord. Weight of chassis is 147 lb., of frame used for attaching it to jig 140 lbs., and of jig itself 1075 lb. Chassis was found satisfactory in every respect.

Longitudinal Stability

Notes on Longitudinal Stability and Balance, E. P. Warner. Aeronautics, vol. 18, no. 349, June 24, 1920, pp. 485-487, 5 figs. Tests made on five aeroplanes—JN4H, DH4, VE7, USAC-11 and Martin Transport. Conclusions arrived at are that tail surfaces should be of large aspect ratio, that stabilizer should be larger than elevator, that tail should be cambered both above and below, that center of gravity should be from 28 to 30 per cent back of mean chord, and that thrust line should be as high as it can be conveniently placed. Technical Notes of United States National Advisory Committee for Aeronautics.

Loughead

The Loughead Sport Biplane. Aerial Age, vol. 11, no. 13, June 7, 1920, pp. 434-435. Specifications: Maximum speed (full load—horizontal flight), 70 m.p.h.; landing speed, 25 m.p.h.; rate of climb, 700 ft.—first minute; service ceiling, 12,000 ft.; gliding angle, 10 to 1; weight, loaded, 600 lb.; fuel consumption, 50 m.p.gal.; range of flight (without replenishing fuel), 450 mi.

Orenco

The Orenco Type F Tourister Airplane. Aviation, vol. 8, no. 7, May 1, 1920, pp. 278-281, 7 figs. Commercial design of Ordnance Eng. Corp. Specifications: Weight, empty, 1477 lb.; fully loaded, 2432 lb.; fuel weight, 200 lb.; range at full speed, 250 miles; speed near ground, 90 m.p.h.; at 5000 ft., 84 m.p.h.; at 10,000 ft., 78 m.p.h.; loading per horsepower, 16.2 lb., and per sq. ft., 7.15 lb.; span, 38 ft.; overall length, 25 ft. 10 in.; height, 9 ft.

Paris Show

Types Exhibited at the Paris Aeronautical Show (Les avions actuels et le 6e salon de l'Aéronautique), L. Marchis. Aérophile, vol. 28, nos. 7 and 8, April 1 and 15, 1920, pp. 108-112, 3 figs. Characteristics of engines.

Performance with Supercharged Engine

Aeroplane Performance as Influenced by the Use of a Supercharged Engine, George de Bothezat. Aeronautics, vol. 18, no. 349, June 24, 1920, pp. 481-482, 1 fig. Advantages of supercharging are pointed out by computing characteristics of performance in two assumed cases. Technical Notes of United States National Advisory Committee for Aeronautics.

Plywood Webs

Shear Strength of Plywood Webs. Eng. Division Air Service, Technical Orders, no. 14, March 1920, pp. 47-60, 6 figs. Tests were made to determine shearing strength of plywood and laminated veneer webs and to determine influence of strength of various factors such as number of plies, thickness of various plies, relative direction of grain in plies, distance between shearing forces, length of shearing section, and direction of shearing forces relative to grain of wood.

Spars, Vibrations of

The Vibration of Spars in Aircraft. Aviation, vol. 8, no. 7, May 1, 1920, pp. 290-291, 9 figs. Experimental investigation of cause of vibrations which take place in lower plane of airplane at high engine speeds.

Sporting

Small Sporting Aeroplanes. Flight, vol. 12, no. 20, May 13, 1920, pp. 519-523, 28 figs. List of sporting aeroplanes of 50 hp. and under. Sketches are included illustrating the different types. From technical memo issued by Controller of Information of Department of Civil Aviation.

Static Testing

Present Procedure in Static Testing of Airplane, Engineering Division U. S. Air Service. Air Service Information Circular, vol. 1, no. 10, March 25, 1920, 15 pp., 12 figs.

Stresses

The Loads and Stresses on Aeroplanes, John Case. Aeronautics, vol. 18, no. 347, June 10, 1920, pp. 448-449, 3 figs. Stresses in spar under combined bending and twisting. (Continuation of serial.)

Struts, Interplane

Location of Interplane Struts. Eng. Division Air Service. Technical Orders, no. 14, March 1920, pp. 61-77, 11 figs. Investigation made to find by trial most economical location for struts of different types of aeroplanes and to determine effect of different variables in changing this location. It was found in part that when spars are continuous, bays tend to increase in proportion to total length, and cantilever to decrease, and that decrease in slope of lift wires or monoplane struts will increase proportionate length of cantilevers.

Torpedo Plane, U. S. Navy

New American Torpedo Plane. Aeronautics, vol. 18, no. 347, June 10, 1920, pp. 444-445, 6 figs. Specifications: Wing spread, over all, 71 ft. 5 in.; spread, wings folder, 35 ft. 10 in.; length, overall, 46 ft. 4 in.; height, overall, 14 ft.; weight, empty, 6533 lb.; weight, gross, 11,487 lb.; maximum speed, 107 m.p.h.; economical speed (at sea level), 95 m.p.h.; climbing speed (from sea level), 5100 ft. in 10 min.; cruising radius, 480 m.p.h.; service ceiling, 12,000 ft.

Wings

Discussion of Stress Analysis of an Airplane Wing Cellule of the Multi-Spar Type of Wing Construction, with Special Reference to the Loading Condition of the Standard Static Test. Air Service Information Circular, vol. 1, no. 52, May 18, 1920, 4 pp., 5 figs. Drift truss and stress diagrams.

The Parker Variable Camber Wing, H. F. Parker. Nat. Advisory Committee for Aeronautics, report no. 77, 1920, 41 pp., 25 figs. Wing ceases to deflect after application of its normal maximum load. This is accomplished by means of an internal bracing system which only comes into operation when maximum deflection has been reached.

Weights of Various Types

Structural Weight Analysis of Airplanes. Air Service Information Circular, vol. 1, no. 39, May 8, 1920, 4 pp., 1 fig. Tabulation of weights for several types.

[See also FLYING BOATS; HANGARS; MINE RESCUE WORK; RADIOTELEPHONY; SEAPLANES; WIND TUNNELS.]

AIR CLEANING

Cottrell Electrical Processes

Air Cleaning by the Cottrell Electrical Precipitation Processes, P. E. Landolt and H. M. Pier. Jl. Engrs. Club of Phila., vol. 37-5, no. 186, May 1920, pp. 198-206, 2 figs. Paper presented before Eastern Chapter of Am. Soc. of Heat. & Vent. Engrs.

AIR COMPRESSORS

Reciprocating

Flywheel Effect for Synchronous Motors Connected to Reciprocating Compressors, R. E. Doherty. Am. Soc. Refrig. Engrs. Jl., vol. 6, no, 3, Nov. 1919, pp. 159-177, 9 figs. Process of obtaining turning effort curve for reciprocating compressor illustrated.

AIRCRAFT

See NAVAL AIRCRAFT.

AIRCRAFT CONSTRUCTION MATERIALS

Steel

Steel for the Structural Parts of Aircraft, John L. Harkness. Jl. Am. Steel Treaters Soc., vol. 2, no. 9, June 1920, pp. 466-469. For light machines, ordinary commercial cold-rolled steel is believed to be most suitable; for medium-sized machines, either 0.2-0.3 or 0.3-0.4 heat-treated carbon steel; and for large machines either chrome-nickel or chrome-vanadium steel. Tables of physical properties of chrome-nickel, chrome-vanadium, carbon and nickel steels are included.

Wood

Properties of Woods at 10 Per Cent Moisture, Air Service Information Circular, vol. 1, no. 53, May 18, 1920, 7 pp., 1 fig. Data available are said to indicate strongly that following species can be substituted for spruce in highly stressed parts: Port Orford cedar, coast-type Douglas fir, Amabilis, Grand, Noble, and white firs, eastern and western white pine, yellow poplar, cucumber, and magnolia.

The Kiln Drying of Woods for Airplanes, Harry D. Tiemann. Nat. Advisory Committee for Aeronautics, report no. 65, 1920, 31 pp., 18 figs. Requirements of wood for use in aircraft are discussed and results obtained in experimental and testing work of Forest Products Laboratory undertaken for Army and Navy during war are given.

AIRSHIPS

Commercial Future

Development and Effect of Transport and Communication. Jl. Roy. Soc. of Arts, vol. 68, no. 3524, June 4, 1920, pp. 462-471 and (discussion) pp. 471-475. Writer regards airship as having successfully emerged from experimental stage, but he thinks that it is yet to be proven that airship possesses commercial value. He sees fair prospects of eventually successful developments of commercial airships, and answers objections generally made against them.

Italian

Modern Italian Airships. Flight, vol. 12, no. 26, June 24, 1920, pp. 663-668, 14 figs. Structural details of airships are given, and probable future developments are visualized.

[See also AEROPLANE ENGINES, Maybach; HANGARS.]

ALLOY STEELS

Tempering, Effect on Hardness

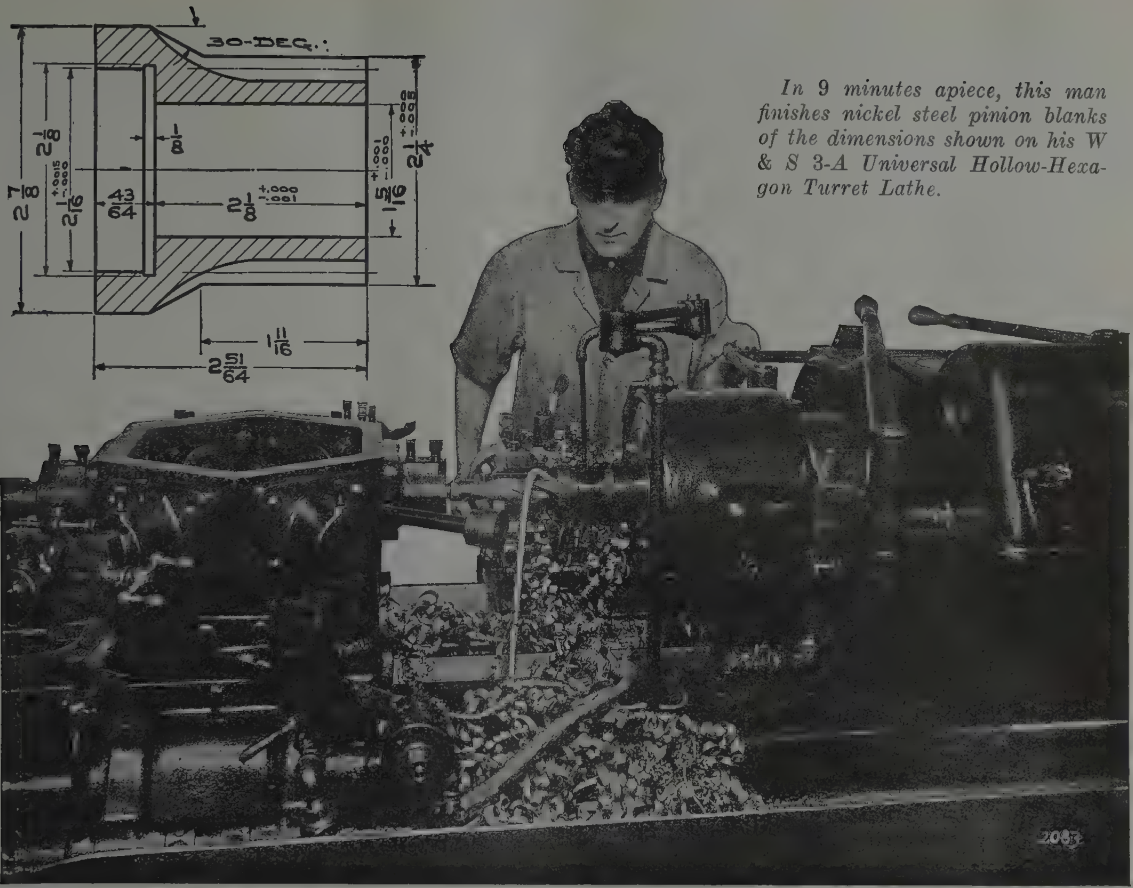
Effect of Tempering on the Hardness of Alloys (Action systématique de la trempe sur la dureté des alliages), L. Grenet. Technique Moderne, vol. 12, no. 3, Mar. 1920, pp. 107-112, 2 figs. Remarks on internal structure of tempered alloys, particularly alloy steels.

[See also STEEL, HIGH-SPEED, MOLYBDENUM STEEL, NICKEL-CHROME STEEL.]

ALLOYS

Cadmium-Arsenic

An Alloy Substitute for Tin and Antimony (Legierung als Zinn-bzw. Antimonersatz). Metall-Technik, vol. 46, nos. 5-6, Feb. 3, 1920, pp. 19-20. According to a process recently patented, cadmium is alloyed with arsenic to form substitute for tin.



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ENGINEERING INDEX (Continued)

ALTERNATORS

See ELECTRIC GENERATORS, A. C.

ALUMINUM

Foundry Losses

Casting Losses in Aluminum-Foundry Practice in the United States, Robert J. Anderson. Monthly Reports of Investigations, Bur. of Mines, Dept. of Interior, April 1920, 3 pp. Average casting loss, including rejections of all kinds on foundry floor, in inspection department and machine-shop returns, is placed at 10 per cent. Variations in losses range, it is said, from 0 to 75 per cent.

Uses in Telegraphy and Telephony

Uses of Aluminum in Telegraphy and Telephony (Aluminium in Telegraphen- und Fernsprechbetrieb), Ulfilas Meyer. Elektrotechnische Zeitschrift, vol. 41, no. 9, Feb. 26, 1920. pp. 170-171. Results of experiments carried out in Telegraphic Experimental Bureau are said to show that in using aluminum for cable lines certain difficulties are met with, and means for diminishing these are suggested. Use of aluminum as bus-bars in engine and storage-battery rooms is said to give satisfactory results; in paper condensers aluminum foil was substituted for tin foil and results are discussed.

[See also NON-FERROUS METALS, Specifications.]

ALUMINUM ALLOYS

Lynite Alloys

Developments in Alloyed Aluminum, R. E. Carpenter. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 86-88, 5 figs. Production of Lynite alloys is recorded, and table of their physical properties is included.

Nickel Plating

Nickel Plating of Aluminum and Its Alloys (Sur le nickelage de l'aluminum et de ses alliages), Léon Guillet and Maxime Gasnier. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 21, May 25, 1920, pp. 1253-1256. Following procedure is reported to have proved successful: Scraping of metal by sand jet under pressure of 1500 gr. per sq. in. nickel-plating for one-half hour under 0.8 amp. per sq. dm.; copper-plating for 2 hours under 1 amp. per sq. dm.; polishing of copper surface; nickel plating for 1 hour under 0.5 amp. per sq. dm.; and final polishing of surface.

AMMONIA

Catalytic Oxidation

The Catalytic Oxidation of Ammonia to Nitric Acid (Die katalytische Oxydation des Ammoniaks zu Salpetersäure), Bernhard Neuman and Herta Rose. Zeitschrift für angewandte Chemie, vol. 33, nos. 14, 16 and 18, Feb. 1, 24 and Mar. 2, 1920, pp. 41-44, 45-48 and 51-55, 11 figs. Results of experiments with various contact substances, such as platinum, ferric oxide mixtures and oxides of chromium, copper and vanadium are given and compared with results obtained by other investigators. Based on resultant determination of gas composition, reaction temperature for certain gas mixtures is calculated and it is shown that under certain conditions the continuous transformation of ammonia into nitric oxide is technically possible without addition of external heat. Report from Inst. for Chem. Technology of Technical High School at Breslau.

Synthesis

Industrial Synthesis of Ammonia by Georges Claude Process (La synthese industrielle de l'ammoniac par le procédé Georges Claude), Jacques Boyer. La Nature, nos. 2397 and 2398, April 10, 1920, pp. 151-156, 7 figs. Method at Montereau works, France.

AMMUNITION

French High-Explosive

Report of Test of French 37 M/M High Explosive Ammunition. Air Service Information Circular, vol. 1, no. 19, May 5, 1920, 10 pp., 7 figs. Object of test was to determine destructive effect of 37 m/m high explosive ammunition equipped with supersensitive fuse.

ANEMOMETERS

Electrical Oscillation

Anemometer Operating by Electrical Oscillations (Sur un anémometre à oscillations électriques), M. E. Rothé, Comptres rendus des Séances de l'Académie des Sciences, vol. 170, no. 20, May 17, 1920, pp. 1197-1198. Fan of anemometer operates as interrupter and at each contact sets electrical vibrator in action.

Hot-Wire

A Directional Hot-Wire Anemometer of High Sensitivity, Especially Applicable to the Investigation of Low Rates of Flow of Gases, J. S. G. Thomas. Proc. Physical Soc. of Lond., vol. 32, part 3, April 15, 1920, pp. 196-207, 3 figs. Instrument consists of two fine platinum wires mounted close together, and forming two of arms of Wheatstone bridge. These are heated by current in bridge. When a stream of gas moves in direction perpendicular to wires, but parallel to plane containing them, leading wire is cooled, while second wire, being shielded by first, is not cooled as much, and may be heated by air flowing past it being warmed by first wire. Deflection of galvanometer is obtained, which is reversed if flow of gas is in reverse direction.

ARCHES

Concrete

Truss Centering Used for 113-Ft. Concrete Arch, C. B. McCullough. Eng. News-Rec., vol. 84, no. 18, Apr. 29, 1920, pp. 851-852, 3 figs. Timber Howe truss adopted instead of falsework because of depth of water in channel of Rogue River Bridge, Oregon.

[See also TUNNELS, Arches in.]

ARMY SUPPLY BASES

Philadelphia

New Terminal at Philadelphia. Mar. Rev., vol. 50, no. 6, June 1920, pp. 347-350, 9 figs. Modifications effected to meet commercial needs.

ASPHALT

German Processes

Technical Asphalt and Pitch Preparations (Technische Asphalt- und Pechpräparate), Emil J. Fischer. Kunststoffe, vol. 10, no. 3, Feb. 1, 1920, pp. 30-32. Includes tabular data of the most important German processes for production of asphalt and pitch preparations. (Continuation of serial.)

AUTOMOBILE ENGINES

Balancing

Balance of V-Engines with Eight Cylinders Set at 90 Degrees (Equilibrage des moteurs à 8 cylindres en V a 90°), H. Petit. Technique Automobile et Aérienne, vol. 11, no. 1, 1920, pp. 6-9, 4 figs. Diagrams of inertia forces, both horizontal and vertical.

Caffort Kerosene

The Caffort Paraffin Engine. Automobile Engr., vol. 10, no. 139, June 1920, p. 242, 4 figs. Built by Caffort Co., Paris, France. Design incorporates Bellem and Bergeras system of fuel supply, which, fitted to Unic engines, won kerosene engine competition instituted by French Automobile Club in 1918.

Cams for

Cams for Radial and Rotary Engines, Wm. John Walker. Automobile Engr., vol. 10, no. 139, June 1920, p. 241, 1 fig. Design of multilobed cam suitable for operating valves of given multi-cylinder engine of four-stroke type, cam being rotated at certain speed in opposite direction to that of crankshaft.

Fuel Consumption, Reducing

Fuel Economy and Engine Design, H. R. Ricardo. Autocar, vol. 44, no. 1287, June 19, 1920, pp. 1135-1140. Possibilities of improving present designs with a special view to economy of fuel. Factors which are mentioned as having great influence on fuel consumption are: (1) Internal friction and (2) design of combustion head. In this connection side-by-side valves are recommended in preference to overhead valves.

Inertia Forces in

Influence of Inertia Forces Upon Torque Variations of an Automobile Engine (Influence des forces d'inertie sur la variation du couple moteur), H. Petit. Technique Automobile et Aérienne, vol. 11, no. 1, 1920, pp. 9-18, 7 figs. Diagrams of inertia forces and torque diagrams, constructed for six-cylinder, eight-cylinder and twelve-cylinder engines.

Vacuum Fuel-Feed System

LePere Vacuum Fuel Feed System for Airplanes. Automotive Industries, vol. 42, no. 26, June 24, 1920, pp. 1450-1451, 5 figs. Investigations of this system, made at McCook Field by Eng. Division of Air Service are said to have established its applicability to motor car. Vacuum of gasolines supply system used on LePere biplane is generated by venturi tube placed in air stream above upper wing. Gasoline is drawn from main supply tank in fuselage to gravity distributing tank in upper wing.

[See also AEROPLANE ENGINES, Construction Materials; CARBURETORS.]

AUTOMOBILE FUELS

Efficient Utilization

Report on the Utilization of Present Fuels in Present Engines. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 25-29, 6 figs. Committee report presented at semi-anual meeting of Society of Automotive Engineers. Question of mixture giving best distribution and most complete combustion, design of manifolds, condensation of fuel and application of heat are taken up.

Gasoline Mixtures

Meeting the Cmbustion Requirements of Present Fuels. Automotive Industries, vol. 42, no. 26, June 24, 1920, pp. 1445-1447 and p. 1449, 6 figs. Preparation of proper combustible mixtures from less volatile gasolines, with notes on vaporization and distribution. Report of Fuel Committee of Automotive Engrs.

Safe Storing of

A New Method of Storing and Supplying Inflammable Liquids (Ein neues Lager- und Förderverfahren für feuergefährliche Flüssigkeiten), George Urff. Automobil-Rundschau, vol. 19, no. 7-8, Apr. 1920, pp. 71-75, 1 fig. Safety apparatus for storing and handling gasoline and other inflammable automobile fuels in garages.

[See also BENZOL; GASOLINE.]

AUTOMOBILES

Armstrong-Siddeley

The Armstrong Siddeley 29.5 H. P. Chassis. Automobile Engr., vol. 10, no. 139, June 1920, pp. 222-230, 26 figs. Six-cylinder model. Specifications: Claudel-Hobson carburetor; three forward speeds and one reverse; front axle of H-section and of reverse Lemoine type of steering head; exceptionally light frame with main side members of 0.1 in. in thickness.

Body Suspension

Notes on the Suspension of Automobile Bodies (Quelques remarques sur la suspension des véhicules automobiles). Technique Automobile et Aérienne, vol. 11, no. 1, 1920, pp. 18-22, 5 figs. Technical study. Special attention is given to influence of size of wheelbase on suspension. It is established that, within certain limits and other things being equal, the smaller the wheelbase, the more effective the suspension mechanism.

Shaft Joints

Flexible Shaft-Joint Progress, Carl A. Schell. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 30-32. It is recommended to make total disk thickness about one-eighth of diameter and center hole of disk about 40 per cent of total diameter.

Steels for Automobile Parts

The Most Suitable Steels for Automobile Parts, W. H. Hatfield. Automobile Engr., vol. 10, no. 139, June 1920, pp. 245-261, 11 figs. Tables are given in which are indicated the various stresses coming upon different automobile parts, the steels being used or which have been used in their construction, and the steels recommended by the writer as a result of tests and analyses of materials.

Three-Wheeled Taxicabs

Three-Wheeled Motor Taxicabs for Berlin (Dreirädrige Kraftdroschken für Berlin). Automobil-Rundschau, vol. 19, no. 5-6, Mar. 1920, pp. 53-54. Because of rapid rise in cost of runing motor taxicabs, the Berlin chief of police has been prompted to make a trial of three-wheeled cabs to ascertain whether they met with requirements of traffic safety and if saving effected in rubber and fuel is not counteracted by increased expense of repairs and shorter life of machine. The special regulations for use of these cabs with regard to construction, tariff, etc., are given.

Wheel Hub Standardization

Hub Standardization Is Getting Under Way, J. Edward Schipper. Automotive Industries, vol. 42, no. 25, June 17, 1920, pp. 1391-1393. Diagram of work to be undertaken by committee of Automotive Metal Wheel Assn.

[See also FERRIES, Automobile; INDUSTRIAL MANAGEMENT, Production Systems.]

AVIATION

Commercial

Over-Cloud Flying and Commercial Aeronautics, Melville Jones. Aviation, vol. 8, no. 10, June 15, 1920, pp. 402-408, 6 figs. Comparative study of over-cloud and under-cloud flying for commercial purposes. It is said that under-cloud flying can be successfully performed commercially by individual effort, but always at serious disadvantage compared with over-cloud flying. Latter, however, it is noted, can only be engaged in commercially with assistance of organization on a large scale and with specially constructed apparatus.

[See also AERONAUTICAL INSTRUMENTS, Turn Indicator.]

AVIATORS

Oxygen Supply

A Note on Oxygen Supply for Aviators, G. B. Obear. Air Service Information Circular, vol.

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ENGINEERING INDEX (Continued)

1, no. 3, March 15, 1920, pp. 44-57, 12 figs. Description of various types of oxygen-supply apparatus.

Physiology

The Aviator's Heart. Roenegen Ray Studies Under Conditions Simulating High Altitudes, Leon T. LeWald, Guy H. Turrell. Air Service Information Circular, vol. 1, no. 3, March 15, 1920, pp. 3-25, 85 figs., partly on 15 supp. plates. Two series of studies were undertaken, one with Henderson rebreather and the other in the low-pressure chamber.

B

BARGES

Oil-Tank

Oil Barges (Chalands Pétroliers). Bulletin Technique du Bureau Veritas, vol. 2, no. 5, May 1920, pp. 94-98, 4 figs. Designs operating in French and German rivers.

Ore

Design of Ore Fleet for Upper Mississippi, William S. Mitchell. Mech. Eng., vol. 42, no. 7, July 1920, pp. 379-382, 4 figs. Writer describes two experimental trips which were conducted during the war to try out possibilities of such transportation on Mississippi river. Results of these trips are said to have warranted construction of fleet of 24 barges and 4 towboats for traffic of ore and fuel. Particulars are given regarding design and construction of vessels, and terminal facilities projected.

Refrigerating

Refrigerating Barges on the Rhine (Rheinkühlschiffe), E. Foerster. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 17-18, May 1, 1920, pp. 341-346, 17 figs. Details of equipment of a large barge for transportation and cold storage of meat, ordered by Inter-allied Army of Occupation and in continuous service at Antwerp since July, 1919. Specifications: Overall length, 79.95 m.; beam, 9.48 m.; loading capacity, 1350 tons; engine, horizontal Dingler-Diesel, 36 hp. at 210 r.p.m.; refrigerating machine, 275 mm. cyl. diam. by 175 mm. stroke, 180 r.p.m.

BEAMS

Reinforced-Concrete

Design of Reinforced-Concrete Beam with Double Reinforcements (Algunas consideraciones acerca del cálculo de las vigas de hormigón con doble armadura), Bartolomé Ferro. Revista del Centro Estudiantes de Ingenieria, vol. 20, no. 211, Jan. 1920, pp. 358-365, 6 figs. Method is suggested which consists in determining stress diagram and computing sections of beam with reference to diagram.

BEARING METALS

Babbitt

The Analysis of Babbitt Metal, H. C. Boehmer, J. R. Gordon and C. W. Simmons. Can. Chem. Jl., vol. 4, no. 6, June 1920, pp. 171-173. Metal considered is the one containing only lead, antimony and tin. Recommendations are given for analyzing metal, such as for example that reduction to stannous salt should be preferably accomplished by means of metallic antimony instead of by zinc.

BEARINGS

Protection Against Heating

Protection of Bearings, etc., Against Heating (Sicherung von Lagern usw. gegen Heisslauf mit selbsttätiger Lagerkühlung), Metal-Technik, vol. 46, no. 3-4, Jan. 20, 1920, pp. 9-10, 1 fig. Details of construction and operation of a device for protection of bearings and other moving machine parts, whereby an alarm is sounded when a certain temperature is reached and a cooling substance is released to flow over bearing.

BELTING

Steel

An Experimental Investigation of Steel Belting, F. G. Hampton, C. F. Leh, and W. E. Helmick. Mech. Eng., vol. 42, no. 7, July, 1920, pp. 369-378, 13 figs. Particulars regarding belt material and joints used. Description of apparatus employed in tests. Determination of relationships existing between horsepower transmitted, velocity of slip on pulleys, and coefficient of friction.

BENZENE

High-Temperature Reactions

Some High-Temperature Reactions of Benzene and Toluene, S. F. Dufton and John W. Cobb. Gas Jl., vol. 150, no. 2978, June 8, 1920, pp. 588-591, 1 fig. Experimental. It was found that benzene passed through heated column of coke with time of contact of about 12 sec. begins to undergo molecular condensation in an inert gas at about 500 deg. cent. with elimination of hydrogen. Toluene similarly treated was found to begin and undergo molecular condensation at 550 deg. cent.

BENZOL

Impurities

Impurities of Benzol Extracted from Industrial Chlorobenzines (Impuretés de benzene extrait des chlorobenzenes industriels), M. F. Bourion. Comtes rendus des Seances de l'Académie des Sciences, vol. 170, no. 20, May 17, 1920, pp. 1181-1184. Chloroform, normal hexane, normal heptane and other substances are claimed to have been detected by fractional distillation.

BLAST-FURNACE GAS

Utilization for Power

Utilizing Blast Furnace Gas for Power, F. H. Willcox. Blast Furnace & Steel Plant, vol. 8, no. 6, June 1920, pp. 337-340. Experience of one plant.

Volumetric Data

Volumetric Data of Blast-Furnace Gas for Determining Utilization of Coal (Emploi direct des analyses en volumes des gaz du haut fourneau pour divers calculs sur l'utilisation du carbone), J. Seigle. Bulletin et Comptes rendus mensuels de la Société de l'Industrie Minérale, vol. 17, no. 5, Jan.-Feb. 1920, pp. 5-18. Calculation of calories produced by combustion of coal from volumetric data of blast-furnace gas.

[See also BOILER FIRING, Blast-Furnace Gas Fuel.]

BLAST FURNACES

Oxygen Enrichment of Air

Oxygen Enrichment of Air in Metallurgy, F. G. Cottrell. Iron Age, vol. 105, no. 26, June 24, 1920, pp. 1791-1793. Application to blast furnace. Possibilities in open-hearth furnace, the converter and in gas producers. Paper read before Am. Iron & Steel Inst.

BLIND

Reading by Ear

The Optophone: An Instrument for Reading by Ear, E. E. Fournier d'Albe. Nature, vol. 105, no. 2636, May 6, 1920, pp. 295-296, 4 figs. Line of luminous dots is thrown on optical system on ordinary print, each dot having different musical frequency. Light constituting these dots is reflected back on to selenium which is put in circuit with battery and high-resistance telephone receiver. Those falling on white paper produce musical note, those falling on black are extinguished.

BOILER FIRING

Blast-Furnace Gas Fuel

Heating Steam Boilers with Blast-Furnace Gas (Etude du chauffage des chaudiéres à vapeur par le gaz de hauts fourneaux), A. Lombard. Chaleur et Industrie, no. 2, Apr. 1920, pp. 93-96, 2 figs. Technical study. It is computed that heating surface of boiler should be 1.45 times that required for a boiler heated with coal and producing the same amount of steam per hour.

Coal vs. Oil

Coal vs. Oil Performance Chart, L. C. Lichty. Power Plant Eng., vol. 24, no. 13, July 1, 1920, pp. 651-652, 2 figs. For determining amount of saving when changing from coal to oil or vice versa.

[See also BOILER OPERATION; FUELS Low-Grade; OIL FUEL, Burning; PULVERIZED COAL, Comparison with Stokers; STOKERS, Tests.]

BOILER OPERATION

CO_2 Readings

Tables for Computing Combustion Data from CO_2 Readings. Power, vol. 51, no. 24, June 15, 1920, pp. 966-968, 1 fig. Chart is included showing effect of hydrogen in fuel on heat loss as indicated by CO_2 readings.

Efficient

Efficient Operation of the Boiler Plant, John D. Morgan. Power, vol. 51, no. 24, June 15, 1920, pp. 957-961, 2 figs. Various types of stokers are treated as regards requirements of design, also effect of boiler feedwater temperature. Plant labor is considered and data and curves are presented that have direct bearing on boiler-room maintenance, together with suitable plant-record sheets.

Flue-Gas Analysis

Graphic Calculation of Flue-Gas Analyses (Zur graphischen Auswertung von Verbrennungsgasanalysen), Hans Meyer. Stahl u. Eisen, vol. 40, no. 18, May 6, 1920, pp. 605-610, 3 figs. Based on works of W. Ostwald, a method for graphic calculation of flue-gas analyses is described which is said to be applicable to every kind of fuel with slight deviations. Gives combustion charts for liquid, solid and gaseous fuels.

Flue-Gas Temperature

Flue-Gas Temperature and CO_2 as a Guide to Furnace Operation, Charles C. Phelps. Power, vol. 51, no. 18, May 4, 1920, pp. 725-727, 2 figs. Special reference is made to oil burners.

BOILERS

Height Above Grate

Correct Height of Return-Tubular Boiler Above the Grate, Henry Misostow. Power, vol. 51, no. 26, June 29, 1920, pp. 1034-1036, 4 figs. It is stated that for best results with bituminous coal, shell of return-tubular boiler should be set as near fire as possible and still provide ample room for gases. Suggestions for determining best distance from shell of boiler to grate in any particular case are given.

Soot Removal

Removing Boiler and Stack Soot with a Steam Jet, Guy S. Hamilton. Elec. Rev. (Chicago), vol. 76, no. 25, June 19, 1920, pp. 1027-1028, 4 figs. Construction and operation features of steam-jet conveyor, similar to steam ash conveyor, for disposal of soot from bottom of stacks, rear of boilers and from economizers.

BRASS

Cadmium in, Influence of

The Influence of Cadmium on the Properties of Brass, Leon Guillet. Foundry Trade Jl. & Pattern-Maker, vol. 22, no. 222, June 1920, pp. 459-460. Tabulated results of experiments with copper alloys containing from 55 to 70 per cent copper. Translated from Revue de Métallurgie.

Corrosion

The Corrosion of Brass in Dilute Electrolytes, J. H. Reedy and Bertram Feuer. Jl. Indus. & Eng. Chem., vol. 12, no. 6, June, 1920, pp. 541-547, 4 figs. It was found in experiments that high concentration of electrolytes favored electrolytic corrosion in an additive way, and retarded, or even inhibited, complete corrosion. Elevated temperatures favored electrolytic corrosion, but diminished complete corrosion by diminution of dissolved oxygen. Contact with metals nobler than brass favored electrolytic corrosion and was without influence on complete corrosion.

BREAKWATERS

See CAISSONS, Concrete.

BRIDGES

See BRIDGES, HIGHWAY; TRESTLES.

BRIDGES, HIGHWAY

Stringers

Load Distribution Over Stringers of Highway Bridges, Eng. News-Rec., vol. 84, no. 25, June 17, 1920, pp. 1209-1210, 3 figs. Iowa tests on 3-in. plank floors are said to indicate that stringer load is only about one-half of wheel concentration.

BUILDING CONSTRUCTION

German Regulations

The New Prussian Building Regulations with Special Regard to Determining of Buckling Resistance (Die neuen preussischen Hochbaubelastungsvorschriften unter besonderer Berücksichtigung der Bestimmungen über Knicksicherheit). Zentralblatt der Bauverwaltung, vol. 40, nos. 7 and 9, Jan. 24 and 31, 1920, pp. 40-42 and 56-60, 6 figs. (To be continued.)

[See also WALLS, Brick.]

C

CABLE TRAMWAYS

Two-Bucket, Design

Design of Two-Bucket Aerial Tramway, Douglas Lay. Eng. & Min. Jl., vol. 109, no. 25, June 19, 1920, pp. 1359-1361, 12 figs. Simple carrier adapted to lowering ore from mine to terminal below mine outlet. Loading and discharge bins. General layout of line and formulæ for power.

CABLES

Mine, Sudden Stresses in

Analytical Study of Effect of Sudden Stresses in Mine Cables (Étude analytique de l'action des chocs sur les cables d'extraction), M. Delbrouck. Revue Universelle des Mines, vol. 5, no. 3, May 1, 1920, pp. 187-219, 6 figs. A formula is derived which involves velocity of propagation of stresses in cable. By appli-

The Engineer, the Gardener and the Lawn Mower

There's an Engineer, a member of the A. S. M. E., who has a nice house in the suburbs surrounded by a hand cultivated lawn.

One Saturday afternoon this summer he was busily engaged in mowing his lawn. He had oiled the mower, pulled the dead grass from around the knife bearings and pushed it along in great style feeling that he was cutting his grass in a 100% manner.

One of sunny Italy's sunniest sons came along and stopped to watch Mr. Engineer.

Said the Engineer to himself, " He thinks I've got a good mower here and know how to handle it. I'll work a little faster and show him how the grass flies when an Engineer's at the helm."

Said the Gardener to the Engineer, " She no cut so good, what? "

" Sure, it cuts fine, I just oiled it up."

" I show you something," came the reply.

Picking up the mower and reaching in his hip pocket for a screw driver the Gardener made a few deft adjustments of the stationary knife, mowed a strip of lawn and left with a wise smile on his face and this parting shot.

" She only cut with half the knife, I fix her now, I know lawn mowers very good."

As the Engineer mowed on merrily cutting twice the grass at every trip he mused to himself.

" No man knows so much about anything but what some specialist can come along and show him something."

Moral: You know the machines you have designed, manufactured, refined, and redesigned. We know bearings. Perhaps we can tell you something about bearings that will be of help to you in making your machines the most modern possible.

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cation of formula it is found that hemp cable is almost 50 per cent stronger for sudden impacts than steel.

CAISSONS

Concrete

Concrete Caissons for Breakwater Construction, J. A. B. Tompkins. Eng. World, vol. 16, no. 8, June 1920, pp. 467-471, 7 figs. Standard design being built in Milwaukee for Indiana Harbor, Ind. Caisson is 54 ft. long with vertical interior cross-walls dividing it into four compartments.

Sinking Methods

Methods Employed in Sinking Large Open Caisson. Eng. News-Rec., vol. 84, no. 19, May 6, 1920, pp. 916-918, 7 figs. Depth of final penetration controlled by friction collar. Winter concreting made safe by heated housing.

CAMS

Design

Study of Mechanisms Operated by Cams (Etude rationnelle des mécanismes commandés par cames), Octave LePersonne. Revue universelle des Mines, vol. 3, no. 1, Sept.-Oct. 1919, pp. 73-109, 9 figs. partly on 4 supp. plates. With special reference to design of cams for operating valves of internal-combustion engines. (Concluded.)

CANALS

New Orleans Harbor

Unwatering the Lock Site of New Orleans Harbor Canal, George R. Goethals. Eng. News-Rec., vol. 84, no. 20, May 13, 1920, pp. 940-943, 2 figs. Sheet-pile cofferdams, driven in successive rows nearer and nearer to lock, cut off porous underlying quicksand strata which are tapped with flowing wells as dams close in.

CAR WHEELS

Chilled-Iron

Manufacturing Chilled Iron Car Wheels—IV and V, H. E. Diller. Foundry, vol. 48, nos. 10 and 11, May 15 and June 1, 1920, pp. 389-396, 15 figs., and 429-434, 8 figs. May 15: Different types of chillers; details of methods of annealing. June 1: Inspection and testing in order to assure adherence to standard specifications.

Grinding, Reclamation by

Economies Possible by Car Wheel Grinding. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 355-358, 3 figs. Practice of various railroads in reclaiming car wheels by grinding, with description of machine developed for grinding mounted car wheels. Cast-iron car wheels with flat spots are reclaimed, it is said, up to 3½ in. long, provided wheel has not made too great a mileage.

Ingots for

Individual Ingots for Tires and Wheels. Iron Age, vol. 105, no. 22, May 27, 1920, pp. 1507-1509, 3 figs. Comparative value of multiple and individual ingots. To secure individual pipeless ingots of uniform composition three conditions are said to be essential: Well-made dead-melted steel, correct ingot-mold proportions, and proper carbonaceous material for ingot top.

CARBURETORS

Claudel

Claudel Carburetor Now Made in America. Aerial Age, vol. 11, no. 10, May 17, 1920, pp. 323-324 and p. 339, 7 figs. Plain-tube automatic compensating carburetors without moving parts. Gasoline is broken up by swift current of air, and emulsion is made inside jet itself before delivery to carburetor proper.

Eureka

The Eureka Carburetor (Le carburateur Eureka). La vie automobile, vol. 16, no. 706, May 25, 1920, pp. 213-214, 4 figs. Jets of gasoline and air flow from opposite directions into "emulsion" chamber, where they mix before passing into cylinder.

Low-Grade-Fuel

Carburetion and Distribution of Low-Grade Fuels, O. H. Ensign. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July, 1920, pp. 19-24 and 50, 11 figs Carburetor is described which is said to produce a mixture which meets theoretical conditions of operation under throttle control with economy and flexibility. Principle involved for metering fuel and air in carburetor is drop in pressure that occurs at center of whirling mass of fluid.

Variable-Air-Pressure Type

Controlling and Atomizing Fuel by Variable Engine Pressures, John G. Willet. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 51-55, 5 figs. Carburetor designed by writer, in which fuel is controlled and atomized by variable air pressure supplied by engine-driven compressor of standard tire-pump dimensions capable of giving maximum pressure of 15 lb. per sq. in.

CASE-HARDENING

Rules for

Practical Casehardening, Theodore G. Selleck. Jl. Am. Steel Treaters Soc., vol. 2, no. 9, June 1920, pp. 460-465. It is emphasized that, no matter what method of operation is employed, "the man is more than the method."

CEMENT

Storage, Effect of

Effect of Storage of Cement, Duff A. Abrams. Structural Materials Research Laboratory, Lewis Inst., Chicago, bul. 6, June 1920, 29 pp. 10 figs. Tests of effect of storage of portland cement in different kinds of packages and under different conditions on its concrete and mortar-making properties. Compression tests of about 1000 6 by 12-in. concrete cylinders of 1-3 standard sand mortar, and about 500 miscellaneous tests, are included. Among results found were that after 3-months' storage in shed in yard cement had 80 per cent of its original strength; after 6-months' storage, 71 per cent; after 1-year, 61 per cent; and after 2-years, 40 per cent.

Tests Show Effect of Storage on Cement Strength. Eng. News-Rec., vol. 84, no. 26, June 24, 1920, pp. 1263-1266, 3 figs. Tests was conducted at Structural Materials Research Laboratory of Lewis Institute at Chicago. It was found that all methods of sack storage give initial weakness, but strength becomes near normal in two years.

Tester, Automatic

A New Type of Automatic Cement Tester, Thorsten Y. Olsen. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 4 pp. 1 fig. Machine resembles ordinary type of automatic shot cement tester, with the one difference that a liquid is used in place of shot.

CENTRAL STATIONS

Canada

Central Electric Station Industry in Canada. Can. Engr., vol. 38, no. 26, June 24, 1920, pp. 593-596, 3 figs. Statistics giving number of stations, total revenue from sale of power, total operating expenses, salaries and wages, number of persons employed, etc. On Jan. 1, 1919, there were 795 central stations developing a total of 1,841,114 hp.

Interconnection with Industrial Plants

Interconnecting Industrial and Central-Station Plants, Cornelius G. Weber. Power, vol. 51, no. 26, June 29, 1920, pp. 1049-1052, 5 figs. With data from a number of individual cases writer gives some indication of large savings in coal, labor and transportation that would be possible from electrical interconnection on a give-and-take basis.

Reactors, Use of

Stabilizing Large Generating Systems. Elec. World, vol. 76, no. 1, July 3, 1920, pp. 5-8, 5 figs. Value of feeder reactance in keeping alternators in synchronism is illustrated by relating instance in which serious breakdown was traced to lack of sufficient protective reactances.

CHARCOAL

Activation of

Charcoal Activation, H. H. Sheldon. Proc. Nat. Acad. of Sciences, vol. 6, no. 4, April 1920, pp. 178-182, 4 figs. Results of experiments at University of Chicago on variations due to heat treatment in absorption of gases by charcoal.

CHEMISTRY

Research in

A Plan for Incentive to Research in Pure and Applied Chemistry, William J. Hale. Jl. Indus. & Eng. Chem., vol. 12, no. 7, July 1920, pp. 690-696. Plan proposed contemplates providing pecuniary facilities whereby technical men will feel justified to engage their activities in research work. Writer emphasizes that "the best men, the live men, the men who have the mental grasp for bigger things, will not tarry too long where life is difficult and honor shallow."

COAL

Caking Value

A New Characteristic For Coal: The Agglutinating Power Curve, F. S. Sinnatt, A. Grounds. Jl. Soc. Chem. Industry, vol. 39, no. 7, April 15, 1920, pp. 83T-86T, 1 fig. Experimental study of influence of degree of fineness of powdered inert matter on caking property of coal. It was found that fundamental property of caking, which varies considerably in different coals, is influenced by degree of fineness of inert substance until, when inert material, finer than 1/90 mesh is taken, caking property of coal may be entirely destroyed by less than its own weight of inert matter.

Coking

Researches on Coal—II, S. Roy Illingworth. Jl. Soc. Chem. Industry, vol. 39, no. 10, May 31, 1920, pp. 133T-138T, 6 figs. Investigations of coking coals. Theory of coking is suggested from results obtained in experiments. Special attention is given to qualities of coke obtained from coking at various temperatures and at different coking times.

Fusain in Coal Dust

Coal Dust and Fusain, F. S. Sinnatt. Lancashire & Cheshire Coal Research Assn., bul. 5, 1920, 19 pp. Research work conducted to determine composition of fusain and amount present in dust produced during working of coal at colliery.

Low-Grade, Distillation of

Sub-Bituminous and Lignite Coals, S. M. Darling. Ry. Rev., vol. 66, no. 26, June 26, 1920, pp. 1096-1098. Economic possibilities of applying distillation methods to large quantities of sub-standard fuels, deposited in various parts of United States. Paper read before International Railway Fuel Association.

COAL HANDLING

Plants

Coal-Handling Plant (Kohlenstapelanlage), H. Hermanns. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 7, Feb. 13, 1920, p. 50-54, 5 figs. Description of coal-handling plant of a Silesian coal mine, main feature of which is said to be a new and rapid type of car dumper with uninterrupted through track. The dumped coal is stored in elevated bins and handled by means of link-belt conveyor.

Coal Handling Plant and Store of the "Old Hickory" Powder Mill, George Frederick Zimmer. Eng. & Indus. Management, vol. 3, no. 25, June 17, 1920, pp. 789-792, 3 figs. Plan and details of 100,000-ton coal-storage plant.

COAL MINES

Cable Installation

The Installation of a Shaft-Cable at Kirkby Colliery, Joseph Bircumshaw. Trans. Instn. Min. Engrs., vol. 59, part 2, May 1920, pp. 109-113, 9 figs. on supp. plate. Method of supporting cable through brickwork walling and through cast-iron tubing illustrated.

Ferric Hydrate from Mine Water

Six Tons of Ferric Hydrate Secured Daily from Water at a Connellsville Mine, L. D. Tracy. Coal Age, vol. 18, no. 1, July 1, 1920, pp. 13-16, 2 figs. By treating mine water with finely ground lime, ferric hydrate is said to be obtained which is used in desulphurization of gas and as a pigment for paint. Purified water is used for quenching coke.

Ventilation

Running Two Fans in Parallel at Bentley Colliery, and other Ventilating Problems, R. Clive. Trans. Instn. Min. Engrs., vol. 59, part 2, May 1920, pp. 135-144 and (discussion) pp. 144-152, 1 fig. Data on comparative mechanical efficiency of running fans singly or in parallel.

Force and Exhaust Systems of Ventilation, R. Z. Virgin. Coal Industry, vol. 3, no. 6, June 1920, pp. 278-280, 1 fig. Features of each, showing advantages and disadvantages. Reference is made to discrepancies in laws of different states.

COAL MINING

Barrier Pillars

What Barrier Coal Has Been and Should Be Left to Protect Anthracite Mines—II, W. B. Richards. Coal Age, vol. 17, no. 23, June 3, 1920, pp. 1135-1140, 10 figs. Survey of formulæ and methods that have been developed for determining size of barrier pillars.

Coal-Cutting Machinery

Economy and Safety are Secured by Use of Alternating-Current Coal Cutters, Charles B. Officer. Coal Age, vol. 17, no. 26, June 24, 1920. pp. 1303-1306, 4 figs. Savings in equipment cost, in power expense and maintenance charges, as well as greater safety are said to accrue from use of alternating instead of direct-current for driving undercutters.

Miners' Nystagmus

The Economic Aspect of Miners' Hystagmus, T. Lister Llewellyn. Colliery Guardian, vol. 119. no. 3101, June 4, 1920, pp. 1565-1567, 5 figs. It is claimed that nystagmus is due to deficiency light in coal mines, and improvement of illumination underground is urged as preventative.

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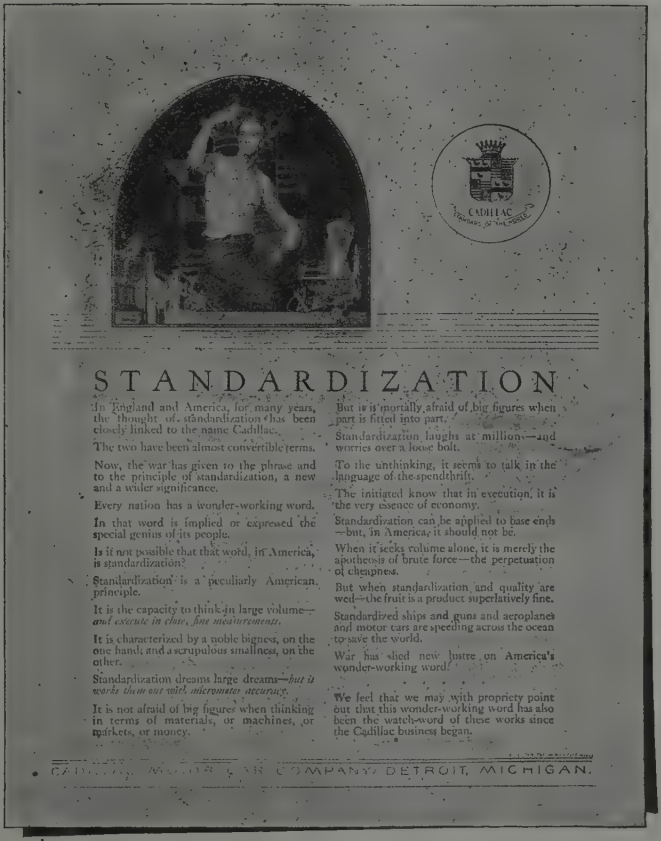

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ENGINEERING INDEX (Continued)

Pneumatic Picks

The Use of Pneumatic Picks in Coal Mining (L'emploi de marteaux a air comprimé pour l'abatage de la houille), M. A. Dessemond. Bul. et Comptes rendus mensuels de la Société de l'Industrie Minérale, vol. 17, no. 2, March-April 1920, pp. 125-143, 2 figs. Records of service at Saint-Etienne collieries, where 70 per cent of coal produced is mined with pneumatic picks.

Power Requirements

Power Requirements for Coal Mining, Robert Anthony. Elec. World, vol. 76, no. 1, July 3, 1920, pp. 14-15, 6 figs. Energy consumption and minimum demand of bituminous coal mines shown under different mining conditions and with varying output of coal. Suggestions made for successfully changing over old mines.

Stripping

Where Stripping is Regarded as a Regular Adjunct to Underground Mining—I. Donald J. Baker. Coal Age, vol. 17, no. 23, June 3, 1920, pp. 1143-1146, 8 figs. Coal is stripped by steam shovel from outcrop to contour, where depth of overburden makes open mining prohibitive. From that line, which is set where cover is 45 ft. deep, to boundary line of property underground mining methods are employed.

[See also EDUCATION, TECHNICAL, Coal Mining.]

COAL WASHERS

Efficiency

Coal-Washing; Further Scientific Studies, Thomas James Drakeley. Trans. Instn. Min. Engrs., vol. 59, part 2, May 1920, pp. 71-93 and (discussion), pp. 93-99, 4 figs. Determination of washer efficiency.

COKE OVENS

By-Product

Recent By-Product Coke Oven Developments, Joseph Becker and F. W. Speer, Jr. Coal Industry, vol. 3, no. 6, June 1920, pp. 281-288, 6 figs. Also Blast Furnace and Steel Plant, vol. 8, no. 6, June 1920, pp. 330-336, 6 figs. Koppers ovens. Triangular flue system, its advantages and resultant increased efficiency secured by installation. Paper read before Blast Furnace & Coke Assn.

COLD STORAGE

British Industry

The Cold Storage Industry in Great Britain: Its Present Position and Potentialities, J. Raymond. Cold Storage & Ice Assn. Proc., vol. 15, 1918-1919, pp. 55-73 and (discussion) pp. 73-82. United Kingdom has about 250 public cold stores of total capacity of about 33,000,000 cu. ft. Privately owned cold storage is estimated to be less than 5,000,000 cu. ft. Referring to figures given in Refrigeration Blue Book, where it is stated that refrigeration has lessened cost of handling consumption of meat of Great Britain, her present cold storage facilities are considered to be entirely insufficient.

Meats, Effect on

Some Application of Chemistry to the Frozen Meat Industry, A. M. Wright. Cold Storage & Ice Assn. Proc., vol. 15, 1918-1919, pp. 31-47 and (discussion), pp. 48-51. Account of investigations on effect of cold storage upon meats conducted in chemical laboratory of New Zealand Refrigerating Co., Ltd.

COLLOIDS

Theories

Solution Theory and Suspension Theory (Ueber "Lösungstheorie" und "Suspensionstheorie"), Richard Zsidmondy. Kolloid-Zeitschrift, vol. 26, no. 4, Jan. 1920, pp. 1-10. Argues that the theory that colloidal solutions are absolutely homogeneous, free from space discontinuities, is not correct, and that definition of solutions should be altered in order to avoid such misleading conceptions; in writer's opinion it is not advisable to use the term "solution theory of colloids."

COMBUSTION

Automatic Control

Automatic Control of Combustion, C. G. Gray. Power Plant Eng., vol. 24, no. 13, July 1, 1920, pp. 649-651, 1 fig. Control of air supply to ashpit by variation in pressure of gases above grates.

Charts for Study of

Graphs for Studying Coal Combustion (Etablissement rapide du bilan thermique par le moyen d'abaques), Ch. De la Condamine. Chaleur et Industrie, no. 2, Apr. 1920, pp. 110-116, 5 figs. Graphs indicating volume of air needed for burning a given quantity of coal, calories contained in coal, losses in boiler furnace, etc.

CONCRETE

Compression Tests

Recommended Practice for Making Compression Tests of Concrete. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 51 pp. 18 figs. Report of tests made to determine effect of tannic acid on strength of concrete is included.

Disintegration by Vacuum

Concrete Destroyed in Vacuum in Calaveras Dam Culvert. Eng. News-Rec., vol. 84, no. 25, June 17, 1920, pp. 1197-1198, 4 figs. Experience in temporary intake led to successful use of vent pipes to break vacuum in new design.

Preservation

Acid Proof Coatings for Concrete Surfaces, Edward H. Berger. Concrete, vol. 16, no. 6, June 1920, pp. 267-269. Specifications for bituminous paints, bituminous enamels and bituminous mastics, prepared by U. S. Bur. of Standards.

Proportioning

Applying Abrams' Water-Ratio to Proportioning Concrete, Stanton Walker. Concrete, vol. 16, no. 6, June 1920, pp. 261-266, 1 fig. Examples are worked out illustrating method.

Rodding, Effect of

Effect of Rodding Concrete, F. E. Giesecke. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 10 pp. 3 figs. Tests showed, it is claimed, that rodding substantially increases strength of concrete, this increase being in many cases more than 100 per cent.

Stress-Deformation Relations

Some Determinations of the Stress-Deformation Relations for Concretes under Repeated and Continuous Loadings, G. M. Williams. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 18 pp. 10 figs. It was found in tests that true stress-deformation relation for concrete is linear up to within 50 to 70 per cent of ultimate strength of concrete; that value of modulus of elasticity for concrete in wet and dry condition is a constant; and that with a given cement and aggregate, and for any fixed proportion of cement to aggregate there is a definite relation between modulus of elasticity and compressive strength for ordinary range of consistencies used in practice.

[See also FLOORS, Concrete, Hardeners for.]

CONDENSERS, STEAM

Vacuum Limitations

Limitations of High Vacuum in Actual Practice, A. D. Bailey. Elec. Rev. (Chicago), vol. 76, no. 25, June 19, 1920, pp. 1019-1020, 2 figs. Economical limits. Paper read before Nat. Elec. Light Assn.

CONTRACT WORK

Cost Estimating

Items Which Estimators Sometimes Omit. Contract Rec., vol. 34, no. 22, June 2, 1920, pp. 498-500. Discusses five components of cost which it is stated should be included in any system of estimating if contracting service is to be fully paid for, namely, financial credit, constructive skill, use of plant, hazard and profit. Report of Committee on Cost Estimating of Northwestern Assn. of General Contractors.

COOLING TOWERS

Selection of

Cooling Towers for Condensers, J. B. Harry. Am. Soc. Refrig. Engrs. Jl., vol. 6, no. 3, Nov. 1919, pp. 178-182 and (discussion), pp. 182-189, 1 fig. Factors influencing selection of water recooling apparatus.

COPPER

Brittleness

A Peculiar Type of Intercrystalline Brittleness of Copper, Henry S. Rawdon. Technologic Papers, Bur. of Standards, no. 158, April 10, 1920, 5 pp., 4 figs. Concerning embrittlement of copper when heated in molten salt bath (sodium chloride) for cleaning or softening purposes. Embrittlement is explained by amount of metallic sodium formed by electrolysis which immediately alloys with copper.

[See also NON-FERROUS METALS, Specification.]

COPPER METALLURGY

Smelter Slags

Copper and Magnetite in Copper Smelter Slags—II, Charles G. Maier and G. D. Van Arsdale. Chem. & Metallurgical Eng., vol. 22, no. 25, June 23, 1920, pp. 1157-1162, 10 figs. Chemical and microscopic examination of series of representative slags, showing how copper losses occur, relation of magnetite to copper loss, behavior of converter slags in reverberatory furnaces and suggestions for reducing copper slag losses.

Smelting

Reverberatory Copper Smelting in Arizona, Charles F. Mason. Eng. & Min. Jl., vol. 109, no. 19, May 8, 1920, pp. 1070-1071, 4 figs. States that furnaces are no longer made with sloping arches, and that large uptakes and flues are being used.

Sulphides, Hydrometallurgy of

Future Hydrometallurgy of Copper Sulphides, William E. Greenawalt. Can. Min. Inst. Bul., no. 97, May 1920, pp. 389-406. It is believed that hydrometallurgy offers effective solution to high shipping and refining costs of copper ores and concentrates. Electrolytic extraction plants, it is maintained, may be installed in any unit and successfully operated without admixture of other ore or fluxes.

COPPER MINES

Alaska

The Salt Chuck Palladium-Copper Mine, J. . Mertie, Jr. Eng. & Min. Jl., vol. 110, no. 1, July 3, 1920, pp. 17-20, 6 figs. Property yielding copper concentrates carries over 3 per cent of palladium per ton. Ore is concentrated by flotation.

COPPER ORES

Arizona

Vertical Extent of Copper Ore Minerals in the Junction Mine. Warren District, Arizona, Graham John Mitchell. Eng. & Min. Jl., vol. 109, no. 26, June 26, 1920, pp. 1411-1412, 2 figs. Both secondary and primary chalcocite are said to occur, the latter only in depth, where it is associated with primary chalcocite and bornite.

[See also FLOTATION, Low Grade Copper Ores.]

CORONA

Motion in Discharge Field

Motion of Droplets and Particles in the Field of the Corona Discharge, Richard C. Tolman and Sebastian Karrer. Chem. & Metallurgical Eng., vol. 22, no. 26, June 30, 1920, no. 1203-1206, 9 figs. Cottrell electrical precipitation process. Apparatus is described in which electrostatic fields were determined. Four different effects were distinguished, but corona discharge is believed to be largely responsible for action of Cottrell precipitators.

CORROSION

Tests for

Tests for Relative Corrosion, Bertram Feuer. Chem. & Metallurgical Eng., vol. 22, no. 26, June 30, 1920, pp. 1197-1198. Comparative study of various methods.

[See also BRASS, Corrosion.]

COST ACCOUNTING

Foundries

Standard Foundry Cost System—I and II. Foundry, vol. 48, nos. 10 and 11, May 15 and June 1, 1920, pp. 407-413 and 438-442. May 15: Cost-accounting system compiled by C. E. Knoeppel & Co., Inc., New York, for American Foundrymen's Association. June 1: Tables showing methods of keeping monthly accounts and profit-and-loss account, also casting cost sheet.

Railway

Cost Accounting—The Key to Cost Control, George W. Armstrong. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 374-379, 12 figs. Discussion on advantages of cost keeping with description of system used by Baltimore and Ohio R. R.

[See also INDUSTRIAL MANAGEMENT, Production Control.]

COTTRELL PRECIPITATION PROCESS

See CORONA.

CRANES

Pontoon

Mare Island Pontoon Crane of 150-Ton Capacity. Eng. News-Rec., vol. 84, no. 26, June 24, 1920, pp. 1245-1248, 3 figs. Heavy structural features include 1000-ton step bearing and long luffing screws without intermediate bearing; 305 tons lifting in test.

Shipyard

A New Type of Shipyard Crane, W. Hok. on & Steel of Canada, vol. 3, no. 5, June 1920, pp. 163-168, 6 figs. Also Shipbuilder, vol. 22, no. 117, May 1920, pp. 321-323, 1 fig. Stationary building-berth type composed

Preliminary Announcement

STABILITY
WHERE IT BELONGS

Something new in Foundation Building

Foundations Free from Tremor or Noise

AN organization is now being completed for the exclusive purpose of designing and constructing foundations for all kinds of machinery, large or small.

Not all vibrations can be eliminated by balancing. The understructure (foundation) can be made a very powerful factor in taking them out.

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Such problems will receive the careful consideration of our experts, and while delays in getting our organization in working order might prevent immediate action, the results will be well worth any slight delay.

The new organization will be entitled

GENERAL
MACHINERY FOUNDATIONS COMPANY
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of stationary main structure and two swinging arms, former consisting of two lattice-work masts placed about 15 ft. 3 in. apart from center to center, and rigidly connected to one another by cross-stays and trusses, making main structure stable in thwartship direction, this obviating necessity of fitting objectionable sidestays. Paper read before Instn. Engrs. & Shipbiulders in Scotland.

Steel Works

The Use of Compressed Air For Steel-Works Cranes (Die Verwendung von Druckluft für Hüttenwerkskrane), H. Geitmann. Stahl u. Eisen, vol. 40, no. 14, Apr. 8, 1920, pp. 461-468, 13 figs. In order to overcome disadvantageous features of the purely electric drive and reduce cost of installation in connection with the electric equipment of giant crane installations, writer recommends use of compressed air, simple electropneumatic control apparatus and continuously running motors with mechanical couplings and brakes capable of being switched on and of being regulated.

CULVERTS

See CONCRETE, Disintegration by Vacuum.

CUPOLAS

Design

Cupola Designed to Save Time and Labor. Iron Age, vol. 105, no. 24, June 10, 1920, pp. 1647-1649, 6 figs. Bottom doors operated by one man. Container receives material direct when bottom is dropped. Clean metal and continuous operation are said to be attained.

CUTTING METALS

Barth Slide Rules

Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—X, Carl C. Barth. Indus. Management, vol. 60, no. 1, July 1920, pp. 49-52, 5 figs. Writer gives theoretical and experimental bases for his milling formula, shows its derivation and then turns to construction of slide rule to give ratio of feed per tooth of milling cutter to thickness of undistorted shaving or chip that is removed.

CUTTING TOOLS

Lathe and Planer Tools

Production of Lathe and Planer Tools, E. G. Blake. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 384-385, 2 figs. It is claimed that grinding from bar stock is economical method of manufacture. Advantages of centralized tool service are pointed out.

D

DAMS

Concrete

Big Eddy Storage Dam—II. Public Works, vol. 48, no. 23, June 19, 1920, pp. 529-534, 9 figs. Monolithic concrete construction 1100 ft. long and 159 ft. high, with gravity cross-section about 100 ft. wide at the base. Attention is directed to special methods of construction necessitated by irregularity of rock bottom which it was necessary first to partially level by submerged drilling, blasting and divers' work before commencing main structure.

Earth

Repairs to Pavement of the Belle Fourche Dam, B. E. Hayden. Eng. World, vol. 17, no. 1, July 1920, pp. 11-13, 4 figs. Dam is earthen structure 6200 ft. long on top and 122 ft. high above cut-off trench at maximum section. Method of repair followed consisted of refilling breaches with gravel, relaying disturbed blocks 6 to 8 in. below grade, and finishing with continuous layer of concrete to grade.

Gravity

Dams for Artificial Lakes Recently Built in Italy (Les digues pour lacs artificiels récemment construites en Italie), Luigi Luiggi. Annales des Ponts et Chaussées, vol. 54, no. 1, Jan.-Feb. 1920, pp. 62-95, 12 figs. partly on supp. plate. Gravity dams.

The St. Maurice River Regulation and the Gouin Dam, Olivier Lefebvre. Jl. Eng. Inst. Can., vol. 3, no. 7, July 1920, pp. 342-348, 3 figs. Gravity dam, 1646 ft. long and 20 ft. wide at crest. Highest section is 90 ft., width at base at that point being 72 ft.

Hydraulic-Fill

Hydraulic Fill Dams (Barrages Hydrauliques). Houille Blanche, vol. 19, no. 39-40, March-April 1920, pp. 41-44, 13 figs. Hubert and Lutz improved bear-trap type. (To be continued.)

Hydraulic-Fill Dams for Miami Conservancy District. Public Works, vol. 48, no. 18, May 15, 1920, pp. 419-422, 7 figs. Method of building up levees, beaches and water-tight core by means of steam shovels window pipes and other contrivances. (Concluded.)

Measuring Internal Pressures in Hydraulic-Fill Cores. Public Works, vol. 48, no. 24, June 26, 1920, pp. 553-555, 3 figs. Earth-pressure cells were varied at different depths in semi-fluid core, where relation between horizontal and vertical pressure indicated rate of solidification of material. Diagrams of pressures obtained are given.

Masonry

Measuring Upward Pressure Under a Masonry Dam, E. W. Lane and E. L. Chandler. Eng. News-Rec., vol. 84, no. 21, May 20, 1920, pp. 1014-1016, 4 figs. Tests made on Island Park Dam at Dayton, Ohio, to determine extent of under pressure through porous foundations.

DIESEL ENGINES

German Submarine

The Diesel Engine of the German Submarine U-117, Holbrook C. Gibson. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 15-18, 1 fig. Engine is of 1200-h.p., six-cylinder type and has air compressor on forward end. Bedplate comes right up, instead of being bolted on flange, and forms housing. Both bedplate and housing are thoroughly ribbed. Cylinder jackets come out in a skirt which gives vertical structure and strength.

High-Altitude Operation

Diesel Engines Under High Altitude Conditions, Theodore M. Robie. Eng. & Min. Jl., vol. 109, no. 23, June 5, 1920, p. 1269, 1 fig. It is shown analytically how pressure in cylinders may be considerably reduced and still obtain same temperature at end of compression as at sea level.

Marine

Progress in Marine Diesel-Engine Building at Krupp's During the War, Otto Alt. Motorship, vol. 5, no. 7, July 1920, pp. 604-606, 5 figs. For 1250 shaft h.p., four-cycle type is being constructed; for over 4000 shaft hp., double-acting port-scavenging two-cycle sets; and for 19,000 shaft hp., four-cycle sets in 12 cylinders with supercompression. (To be continued.)

The Sulzer Two-Stroke-Cycle Marine Diesel Engine (Der Sulzer-Zweitakt-Dieselmotor als Antriebsmaschine von Frachtschiffen). Schiffbau, vol. 21, nos. 21 and 22, Apr. 14 and 21, 1920, pp. 583-589 and 617-621, 18 figs. It is claimed that the two-stroke engine in regard to dimensions and weights and therefore construction costs, is greatly superior to the four-stroke engine, and that in comparison with other cargo ships, the two-stroke motorship with equal water displacement possesses much the greatest carrying capacity.

Supercharging

Surcharging Diesel Engines, Cl. Ruegg. Power, vol. 51, no. 18, May 4, 1920, pp. 712-714, 9 figs. Surcharging is said to have proven successful with two-cycle Diesel engine for direct connection to air compressor in plant operated at 6000 ft. above sea level.

DISTILLATION

Brown's Formula for

On Brown's Formula for Distillation, Sydney Young. Sci. Proc. Roy. Dublin Soc., vol. 15, no. 47, Jan. 1920, pp. 667-672. Brown's formula was found to be applicable without serious errors to mixtures of benzene and toluene.

DRAINAGE

Channel Walls, Maintenance of

Gunite Maintenance of Chicago's Drainage Channel Walls, W. T. Christine. Eng. World, vol. 16, no. 8, June 1920, pp. 459-461, 6 figs. Treatment of breaches in wall is illustrated.

DREDGING

Centrifugal-Pump

Dredging New Orleans' Inner Harbor Navigation Canal. Walter J. White. Proc. Louisiana Eng. Soc., vol. 6, no. 2, April 1920, pp. 80-102, 12 figs. Performance and tests of centrifugal dredging pumps. Paper presented at joint meeting of Louisiana Eng. Soc. and Local Chapter of Am. Soc. of Mech. Engrs.

DROP FORGING

Die-Block Standardization

Physical Requirements of Die Blocks. W. C. Peterson. Am. Drop Forger, vol. 6, no. 6, June 1920, pp. 297-299. Urges that plan be formulated for correct study of use of die blocks and their attendant failures. Paper read before Am. Drop Forge Assn.

Reasons for Standardizing of Die Blocks. C. B. Porter. Amer. Drop Forger, vol. 6, no. 6, June 1920, pp. 286-287. Urges necessity of standardizing die blocks with respect to their size, the quality of steel used, the method of forging and annealing and the hardening treatments for safe operation. Paper read before Am. Drop Forge Assn.

E

EARTHQUAKES

Worldquakes

Worldquakes and Long Waves (Ueber Weltbeben und lange Wellen), K. Mack. Physikalische Zeitschrift, vol. 21, no. 1, Jan. 1, 1920, pp. 7-11, 1 fig. Worldquake is term used to define earthquake of such force that the whole earth surface is shaken. As results of investigations at Holdenheim observatory, a new definition of worldquake is given; formulae are presented by which calculation can be made of distance from seat of quake from moments at which waves are recorded in seismogram of a single observation station, and these formulae are applied for the determination of the seat of worldquake of June 26, 1917.

EDUCATION, ENGINEERING

Professional Spirit in

The Professional Spirit in Engineering Education, C. R. Mann. Eng. News-Rec., vol. 84, no. 26, June 24, 1920, pp. 1242-1244. Current schooling, it is said, is conspicuously designed to inspire individual to make most of himself for the sake of his own success, while required training must inspire individual to make most of himself for the common good.

EDUCATION, TECHNICAL

Coal Mining

The Training of Students in Coal-Mining, with Special Reference to the Scheme of the Engineering Training Organization, F. W. Hardwick. Trans. North England Inst. Min. & Mech. Engrs., vol. 69, part 2, Feb. 1919, pp. 13-20 and (discussion) pp. 20-28. Engineering Training Organization is a British institution formed to serve as central organzation for improvement in and better coördination of engineering training.

ELECTRIC CIRCUITS, A. C.

Protection

The Protection of Alternating-Current Systems Without the Use of Special Conductors, Kenelm Edgcumbe. Jl. Instn. Elec. Engrs., vol. 58, no. 291, May 1920, pp. 391-407 and (discussion) pp. 407-416, 30 figs. Possible schemes.

Three-Phase, Unbalanced

Unbalanced Three-Phase Circuits, Waldo V. Lyon. Elec. World, vol. 75, no. 23, June 5, 1920, pp. 1304-1308, 9 figs. Analytical and graphical methods of treating problems arising from operation of three-phase apparatus on unbalanced voltages. Examples are given to illustrate theory.

ELECTRIC CONDUCTORS

Resistance and Inductance Formulae

An Integration Method of Deriving the Alternating-Current Resistance and Inductance of Conductors, Harvey L. Curtis. Sci. Papers, Bur. of Standards, no. 374, April 7, 1920, pp. 93-124, 4 figs. Method consists in dividing conductor into infinitesimal filaments by surfaces which coincide with lines of current flow. Magnetic field at any point is sum of magnetic fields of these filaments. Counter e. m. f. in a filament is determined by rate at which magnetic fields of all other filaments cut this filament.

ELECTRIC CURRENTS

Comparator of

A Dynamometrical Comparator. Edy Velander. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 680-686, 8 figs. Differential dynamometer for accurate comparison of alternating and direct-current strengths.

ELECTRIC CURRENTS, ALTERNATING

Bridge Measurement

Bridge Methods for Alternating-Current Measurements. D. I. Cone. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 640-647, 18 figs. Résumé of simple methods of utilizing "bridge" networks in alternating-current measurements of impedances and their components of effective resistance, self and mutual inductance and capacitance, and in frequency measurement. Bibliography is appended.

ELECTRIC FURNACES

Electrodes

Electrodes for Iron and Steel Furnaces, C. G. Vom Baur. Iron Age, vol. 105, no. 24, June 10, 1920, pp. 1653-1654. Comparison of carbon and graphite. Question of metallic electrodes. Cooling collars and carbon consumption.

Greaves-Etchells

Electric Steel Furnaces and Electric Steel, F. J. Cleary. Jl. Am. Soc. Naval Engrs., vol.

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32, no. 2, May 1920, pp. 242-310, 16 figs. Special reference is made to steel castings and Greaves-Etchells type of electric furnace. Compilation of information which has appeared in technical papers in United States and England.

Heat-Treating

A Modern Tool Room Heat Treating Plant. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 389-391, 3 figs. Electric furnaces and pyrometers installed at Ft. Wayne shops of Pennsylvania system.

Induction

Induction Furnaces and Their Application in the Iron and Steel Industry (Les fours à induction et leur application dans l'industrie du fer et de l'acier), W. Engelhardt. Houille Blanche, vol. 19, no. 39-40, March-April 1920, pp. 58-61, 6 figs. Kjellin German types. (Continuation of serial.)

ELECTRIC GENERATORS, A. C.

Radio-Frequency

Radio Frequency Alternators, Marius Latour. Proc. Inst. Radio Engrs., vol. 8, no. 3, June 1920, pp. 220-237, 18 figs. Types of radio-frequency alternators, with special reference to those most used in France at present. Translated from Bul. de la Société Française des Electriciens.

Waterwheel-Driven

Vertical-Shaft Waterwheel-Driven Alternators—Brakes, Ventilation and Exciters, S. H. Mortensen. Power, vol. 51, no. 24, June 15, 1920, pp. 953-954, 3 figs. Brakes operated by hand and compressed air, ventilation of alternators and excitation with direct-connected and independent exciters.

Vertical-Shaft Waterwheel-Driven Alternators—Mechanical Features, S. H. Mortensen. Power, vol. 51, no. 18, May 4, 1920, pp. 698-700. Structural details of several large units, special 32,500-kva. machine, said to be largest hydro-electric unit in the world.

[See also TURBO-ALTERNATORS.]

ELECTRIC LAMPS, ARC

Cadmium-Vapor

A New Cadmium-Vapor Arc Lamp, Frederick Bates. Sci. Papers, Bur. of Standards, no. 371, April 10, 1920, pp. 47-50, 2 figs. Alloying cadmium with gallium is reported to have overcome continued breakage of Sand cadmium-vapor arc lamp.

Rotating-Arc

Rotating-Arc Lamp (Lampe a arc rotatif). Industrie électrique, vol. 29, no. 667, April 10, 1920, pp. 125-126, 1 fig. Positive electrode is a carbon placed along axis of negative electrode which is made of metal and has annular shape. Solenoid surrounds annular electrode. Current through solenoid causes rapid rotation of arc. Negative electrode is cooled by water.

ELECTRIC LOCOMOTIVES

N. Y., N. H. & H. R. R.

180-Ton New Haven Electric Lcomotives, F. W. Carter. Ry. Age, vol. 68, no. 23, June 4, 1920, pp. 1563-1565, 5 figs. Power collected from 600-volt overrunning or underrunning third rail or from 11,000-volt overhead wire. Specifications: Classification, 2-6-2-2-6-2; number driving wheels, 12; diameter driving wheels, 63 in.; total weight, including sand, oil and water, 170 tons; overall length, 69 ft. 0 in.; method of drive, geared; maximum speed, 70 m.p.h.

Single-Phase

1C + C1 Freight Locomotives for the Gotthard Line of the Swiss Federal R. R. (1C+C1 Güterzug-Lokomotiven für die Gotthardlinie der S. B. B.). Schweizerische Bauzeitung, vol. 75, nos. 21 and 22, May 22 and 29, 1920, pp. 229-232 and 237-241, 20 figs., 2 on supp. plate. Details of single-phase alternating-current, 2200-hp. locomotive. Specifications: Wheel base, 16.5 m.; driving wheel diam., 1.35 m.; weight, including personnel and supplies, 129 tons; maximum axle load, 18.2 tons; maximum speed, 65 km. per hr., etc. Notes on electrical equipment based on data obtained from the Oerliken Machine Works.

Switzerland

New Single-Phase Locomotives of the Federal Swiss Railways (Les nouvelles locomotives monophasées des chemins de fer fédéraux), Lucien Pahin. Industrie Électrique, vol. 29, no. 665, March 10, 1920, pp. 85-92, 9 figs. Specifications of 2-4-4-2 passenger type: Length overall, 16.5 meters; diameter of driving wheels, 1.35 m.; weight of electric equipment, 49.6 tons; total weight, 107.6 tons; maximum speed, 75 km. per hr. Specifications of 2-6-6-2 freight type: Length overall, 19.24 m.; diameter of driving wheels, 1.35 m.; weight of electric equipment, 51.2 tons; total weight, 121 tons; maximum speed, 65 km. per hr. Power is transmitted by gears in both types.

ELECTRIC MOTORS

See FANS, CENTRIFUGAL, Motors for.

ELECTRIC MOTORS, A. C.

Induction

Induction Motors Running at Different Frequencies (Contribution à l'étude des moteurs asynchrones fonctionnant à des fréquences différentes), J. Patin. Revue générale de l'Électricité, vol. 7, no. 23, June 5, 1920, pp. 778-781, 3 figs. From circle diagram of motor designed for a certain frequency *f*, conditions of operation of the same motor for a different frequency *f'*, are derived.

ELECTRIC PLANTS

Changing from Two to Three Phase

Changing System from Two to Three Phase, George H. Hagar. Elec. World, vol. 75, no. 25, June 19, 1920, pp. 1414-1416, 4 figs. By adding booster transformer both two-phase and three-phase energy is said to have been obtained from four-wire system during reconstruction of system in a California city.

Pacific Northwest

Electric Power Development in the Pacific Northwest. Elec. Rev. (Chicago), vol. 76, no. 20, May 15, 1920, pp. 806-822, 24 figs. Principal hydroelectric and steam-electric plants. Central-station construction, equipment, operating features, transmission lines and power distribution systems in that section.

Southern California

Southern California Edison Co.'s Power System, W. A. Scott. Elec. Rev. (Chicago), vol. 76, no. 20, May 15, 1920, pp. 798-805, 10 figs. General outline of power plants, water-storage facilities, transmission lines and distribution system, with details of important construction, operating and servce features. Energy-producing capacity amounts to 203,000 kw., of which 117,000 kw. is furnished by hydroelectric stations and 86,000 kw. by steam-driven generators.

ELECTRIC POWER

Long-Distance Transmission

Conditions of Maximum Efficiency of Long Distance Electric Power Transmission (Des conditions optima à remplir par les constantes d'une ligne de transport d'énergie à grande distance pour une charge donnée à l'arrivée. Solutions pratiques), A. Blondel. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 18, May 3, 1920, pp. 1032-1037. Method outlined in Comptes rendus, vol. 170, 1920, p. 978, is applied to various practical cases.

ELECTRIC RAILWAYS, TRACK

Labor-Hour Requirements

Estimating Labor Hour Requirements for Three Types of Street Railway Track Construction, D. B. Davis. Mun. & County Eng., vol. 58, no. 6, June 1920, pp. 239-240, 3 figs. Based on data obtained in construction of work at Richmond, Ind.

Rail Joints

Modern Methods of Prolonging Track Life, E. A. Hoffman. Elec. Ry. Jl., vol. 55, no. 25, June 19, 1920, pp. 1258-1260. Arc welding of rails followed by grinding is said to give joint life equal to that of rail. Bonding, roadbed construction and tie treatment, are also taken up.

ELECTRIC RESISTANCE

Inductionless

A Form of Inductionless High Resistance, N. W. McLachlan. Radio Rev., vol. 1, no. 9, June 1920, pp. 429-431, 3 figs. Solution of cadmium iodide in amyl alcohol used at Nat. Physical Laboratory, England.

ELECTRIC TRANSMISSION LINES

Electrical Characteristics

Calculation and Diagrams of the Electrical Characteristic of Long Distance Electric Transmission Lines (Calculs et diagrammes des lignes de transport de force à longue distance), M. L. Thielemans. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 20, May 17, 1920, pp. 1170-1173, 1 fig. Diagram combining the two formulæ for expressing relations between voltages and current intensities at both extremities of line.

Hardware for

Application of Mild and Alloy Steels to High-Tension Suspension Lines, L. R. O'Neill. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 637-640. Discussion of application of stamped and pressed steel units of mild, structural and alloy steel of suspension problem in high-tension transmission. Factors to be considered in design of hardware for line construction.

Long-Distance

Long Distance Electric Transmission Lines (Sur les lignes de transmission à longue distance), P. Bunet. Revue générale de l'électricité, vol. 7, no. 23, June 5, 1920, pp. 769-778. It is explained how properties of semi-wane lines may be imparted to lines about 500 km. long by addition of self-induction or capacity. (Concluded.)

Sinusoidal Currents in

Propagation of Sinusoidal Currents on Non-Uniform Lines (Propagation des courants sinusoïdaux sur des lignes quelconques), C. Ravut. Revue générale de l'Électricité, vol. 7, no. 19, May 8, 1920, pp. 611-615. By non-uniform lines are meant those in which, resistance, self-induction, loss and capacity per unit of length do not remain constant in the whole length of the line. Equations of propagation in such lines are studied.

ELECTRIC WELDING, ARC

Locomotive Repair Work

Electric Welding in Locomotive Repair Work, W. C. Williams. Ry. Engr., vol. 41, no. 485, June 1920, pp. 246-250, 8 figs. Discusses influence of electric welding on locomotive design and repairs in United States.

Metal Deposition in

Metal Deposition in Arc Welding—I, O. H. Eschholz. Elec. World, vol. 75, no. 26, June 26, 1920, pp. 1473-1475, 5 figs. Mechanism of metal transfer from electrode to plate is explained by aid of photography. Evidence indicates that 85 per cent of metal is carried across arc in liquid form by molecular forces.

Speed of

Speed of Metal Arc Welding, Wm. Spraragen. Welding Engr., vol. 5, no. 6, June 1920, pp. 44-47, 14 figs. Data are said to show that an operator can deposit 1.8 lb. per hour, this rate being less for outside work such as that done on boats. Curves are given which show time, metal and current used with welds of different metals. Paper read before Am. Welding Soc.

Structural Steel

Welding Structural Steel Work, H. B. Payne. Elec. World, vol. 75, no. 25, June 19, 1920, pp. 1421-1422, 6 figs. Results obtained through use of electric welding for building up structural framework for small building erected by Elec. Welding Co. of America. It is said that work, which would have cost $85 per truss for riveting, was done by welding at cost of $50 per truss.

ELECTRICAL ENGINEERING

Research Problems

Research Problems in Electrical Engineering, Vladimar Karapetoff. Elec. Rev. (Chicago), vol. 76, no. 25, June 19, 1920, pp. 1025-1026. Classification of present-day considerations in connection with broader aspects of research in electrical field.

ELECTRICAL MACHINERY

Progress During War

Progress in the Construction of Electric Machines During the War (Fortschritte im Elektromaschinenbau während des Kriegs), E. Rosenberg. Elektrotechnische Zeitschrift, vol. 41, no. 9, Feb. 26, 1920, pp. 165-166. Refers to construction of large turbo-generators and transformers, introduction of air filters manufactured withut fabric, electric propulsion of ships, traction experiments with direct current of 5000 volts development of mercury rectifiers for high and normal voltages, and electric welding, especially in shipbuilding.

Voltage Standardization

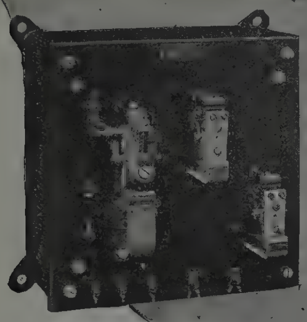
Standardization of Operating Voltages in Switzerland—VI and VII (Zur Frage der Vereinheitlichung der Betriebsspannungen in der Schweiz). Schweiz. Elektrotechnischer Verein Bul., vol. 11, nos. 4 and 5, Apr. and May, 1920, pp. 79-89 and 113-115, 5 figs. Low-voltage standards (100 to 800 volt) as presented by the Swiss Electrotechnical Assn., who recommend that manufacturers of electric apparatus adopt them so that a rational and standard apparatus may be produced more cheaply.

ELECTROMETALLURGICAL INDUSTRIES

Washington State

Electrometallurgical and Electrochemical Industry in the State of Washington, Charles Denham Grier. Eng. Experiment Station, Univ. of Washington, Bul. no. 5, Mar. 1920, 45 pp. Statistics of developed water power and of potential water power, and its cost, with data on electric steel melting furnaces, and sodium nitrate production. Possibilities of manufac-

Continuous motor operation—insured by reliable control equipment—reduces to a minimum expensive production interruptions.



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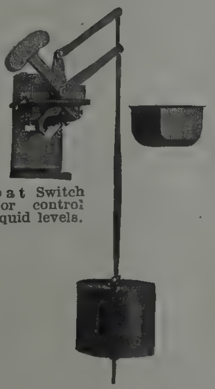

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ture of aluminum and electrochemical production of zinc are pointed out.

ELEVATORS

Safety Devices

Making Freight and Passenger Elevators Safe. Contract Rec., vol. 34, no. 25, June 23, 1920, pp. 612-614. Causes of accidents and their elimination. Paper read before Ontario Safety League.

EMBANKMENTS

See RAILWAYS, Embankments.

EMPLOYEES' REPRESENTATION

Experiences

Co-operation Tends to the Increase of Output. Iron Age, vol. 106, no. 3, July 15, 1920, pp. 131-133. Replies received to inquiry sent to various metal-working companies as to their experience with employee representation plans. Several companies reported adoption of organization plans which resulted in closer coöperation between management and employees.

Organization

Workmen's Congress Solves Wage Problem. Iron Age, vol. 105, no. 24, June 10, 1920, pp. 1651-1653, 1 fig. Representative scheme organized at plant of Reliable Stove Co., Cleveland.

Standard Oil Co. Plant

Speeches at a Standard Oil Meeting of Employees' and Company's Representatives, Burton Kline. Indus. Management, vol. 60, no. 1, July 1920, pp. 1-8. Speeches made at joint annual meeting of employees' and Company's representatives. Subjects discussed were questions of coöperation between employers and employees, details of employees' representation, etc.

Whitley Scheme

Scope, Purpose and Effects of the Whitley Scheme, A. Rowland-Entwistle. Indus. Management, vol. 60, no. 1, July 1920, pp. 8-10. British scheme for effecting employees' representation in industrial plants.

EMPLOYEES, TRAINING OF

Machinists

Correlation of Shop and Classroom Work in Training Machinists. Automotive Industries, vol. 42, no. 26, June 24, 1920, pp. 1463-1465, 3 figs. Course of apprentice machinists conducted by Goodyear Tire & Rubber Co.

EMPLOYMENT MANAGEMENT

Industrial Training and

Employment Management and Industrial Training, Roy W. Kelly. Federal Board for Vocational Education, bul. no. 48, Oct. 1919, 106 pp. Economical and social losses resulting to nation from lack of education or faulty education of wage earners in industry are pointed out, together with more important difficulties to be overcome in preventing them, and practical methods are suggested by which industries and educational institutions may coöperate in industrial training.

Records

Visualizing Employment Records, W. S. Wells. Indus. Management, vol. 60. no. 1, July 1920, pp. 67-70, 6 figs. Method of keeping records at Newburgh Shipyards.

ENAMELS

Titanium

Titanium Enamels, Robert D. Landrum and Leon J. Frost. Jl. Am. Ceramic Soc., vol. 3, no. 4, April 1920, pp. 316-321, 2 figs. It is concluded from results obtained in trials that too high content of TiO_2 increases specific gravity of frit to such an extent that it is extremely difficult to keep it in a satisfactory state of suspension by ordinary means. Other investigations were undertaken regarding opacity and ground coat properties of titanium enamels.

ENGINEERING SOCIETIES

Federated American Engineering Societies

Organizing Conference Plans Federation of Engineering Societies. Mech. Eng., vol. 42, no. 7, July 1920, pp. 422-423. Also in Jl. Am. Inst. Elec. Engrs., vol. 39. no. 7, July 1920, pp. 690-692, and Min. and Metallurgy, no. 163, July 1920, pp. 7-13. Account of conference of 71 engineering organizations and allied technical societies, held at Washington on June 3 and 4. A new organization, The Federated American Engineering Societies, was created, which is to represent profession in matters of common concern and in national and state affairs.

Federated American Engineering Societies, L. P. Alford. Indus. Management, vol. 60, no. 1, July 1920, pp. 53-55.

ENGINEERS

National Organization

The Proposed Comprehensive Organization of National, Local, State and Regional Engineering Societies for the Advancement of the Welfare of the Engineers, Edward J. Cattell. Jl. Engrs. Club of Phila., vol. 37-5, no. 186, May 1920, pp. 209-215. Addresses made by President of Am. Soc. of Mech. Engrs., Am. Soc. of Civil Engrs., and Am. Inst. Electrical Engrs. and a Past President of the Am. Inst. of Min. & Metallurgical Engrs.

ENGINEHOUSES

Mallet Compound Locomotives

An Engine House for Mallet Compound Locomotives. Ry. Age, vol. 68, no. 26, June 25, 1920, pp. 1975-1976, 2 figs. Eight-stall engine house with total depth of 120 ft. from center of columns of inner circle to inside of wall at back. It is constructed upon concrete foundations with cncrete engine pits 90 ft. long and floor of same material.

EXPLOSIVES

Fulminate of Mercury

By-Products in the Manufacture of Fulminate of Mercury (Nebenprodukte bei der Knallquecksilber-Darstellung), H. Langhans. Zeitschrift für das gesamte Schiess- u. Sprengstoffwesen, vol, 14, nos. 18 and 19, 2nd Sept. and 1st Oct. issues, 1919, pp. 300-304 and 318-321, 2 figs. Notes on condensing liquor or crude ether. Results of investigations are said to show that quantity of distillation product recovered depends upon size, shape and number of condensing chambers connected with one retort, from weather and season of year, suction capacity of exhauster, etc. Notes on chemical reaction of nitrate of silver solution, iodine reaction, and behavior of the liquor in relation to metals. (To be continued.)

Liquid Oxygen

Development of Liquid Oxygen Explosives during the War, George S. Rice. Dept. of Interior, Bur. of Mines, technical paper no. 243, 1920, 46 pp., 6 figs. Gives essential results of experiments conducted by Bur. of Mines, observations of liquid explosives of bureau committee sent abroad, and discusses possibilities of applying explosives to mining in United States.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS, CENTRIFUGAL

Motors for

Motors for Driving Ventilating Fans, William H. Easton. Power, vol. 51, no. 19, May 11, 1920, pp. 759-761, 6 figs. Characteristics of motors for fan drives. Comparisons between alternating-current and direct-current motors. Methods of control and formula for calculating horsepower required to drive fans.

FARM MACHINERY

Operating Speeds

The Operating Speeds of Agricultural Implements, Percival White. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 47-50. Opinions of experts are quoted concerning increasing operating speeds of farm machinery, particularly plowing tractor. Majority of them believe that "an acceleration in implement speeds is bound to come, but that its coming will be gradual and slow."

[See also MOTOR PLOWS.]

FATIGUE

Industrial

Studies in Industrial Physiology: Fatigue in Relation to Working Capacity, Joseph Goldmark, Mary D. Hopkins, Philip Sargant Florence and Frederic S. Lee. Treasury Dept., Public Health Bul. no. 106, Feb. 1920, 215 pp., 40 figs. Comparison of an eight-hour plant and a ten-hour plant. Average output per worker, or group of workers, for each hour of day, is given in figures and tables. Conspicuous feature of eight-hour plant is its steady maintenance of output in contrast to fluctuations of output of ten-hour plant.

FERRIES

Automobile

A Double Decked Automobile Ferry with a Winton Diesel Electric Drive, Renwick Z. Dickie. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 556-558, 2 figs. Dimensions: Indicated hp., 1000; fuel used per hour, 1.7 bbl.; length overall, 205 ft.; beam, 44 ft. Plant consists of two 500-hp., eight-cylinder engines.

FILTRATION

Filtrate Classification

Scientific Control of the Filter Station—I, Arthur Wright. Chem. & Metallurgical Eng., vol. 22, no. 22, June 2, 1920, pp. 1015-1017. Discussion on clarification of filtrate. Use of lighter filter cloths made of open woven fabrics advocated. Method of application and use of filter-aids.

Press Operation

Scientific Control of the Filter Station—V, Arthur Wright. Chem. & Metallurgical Eng., vol. 22, no. 26, June 30, 1920. . General discussion and summary of features on filter press operation. Types of presses and their application. Materials used in construction of presses, pressure devices, scope of centrifuging, decantation and flotation.

FIREBRICK

Porosity and Volume at Furnace Temperatures

Porosity and Volume Changes of Clay Fire Bricks at Furnace Temperatures, George A. Loomis. Technologic Papers Bur. of Standards, no. 159, April 26, 1920, 29 pp., 3 figs. Experimental investigation. Bricks which were capable of withstanding pressure of 40 lb. per sq. in. at 1350 deg. cent. showed slight changes in volume or porosity when burnt at temperatures up to 1425 deg. cent. Large number of bricks which failed to pass load test showed marked change in volume or in porosity at some temperatures below 1425 deg. cent. Bricks which showed distinct overburning by pronounced expansion at temperatures below 1400 deg. cent. invariably failed in load test.

FLOATING DOCKS

Tests

Floating Docks and Similar Steel Structures (Die Statische Berechnung von Schwimmdocks und ähnlichen Eisenwasserbauten), L. Karner. Eisenbau, vol. 11, no. 2, Jan. 30, 1920, pp. 41-62, 27 figs. Results of investigation of floating structures with a main bulkhead, starting from which, at equal distances on each side, are square frames connected with one another by longitudinal frames. Two cases of stress are considered which, it is said, cover all possibilities of stress occurring in general practice. A solution method is given based on determination of a series of constants, dependent only upon measurements of floating body, and from this, it is said, all other quantities can be derived in simple manner, and all deflections and bending lines can be determined. (Concluded.)

FLOOD CONTROL

Miami Conservancy District

Effect of Flood on Miami Conservancy Work. Eng. World, vol. 17, no. 1, July 1920, pp. 1-5, 5 figs. Operation and action of hydraulic pump as utilized in outlet works of district dams.

FLOORS

Concrete, Hardeners for

Floor Hardener Tests by Bureau of Standards. Concrete, vol. 16, no. 6, June 1920, pp. 279-280. Service tests of concrete floor hardeners. Types tested were magnesium fluosilicates, varnishes and paints, waxes and various preservatives.

FLOTATION

Low-Grade Copper Ores

Developing a Mill Flow Sheet at Morenci, Ariz., Arthur Crowfoot and Ernest Wittenau. Eng. & Min. Jl., vol. 109, no. 25, June 19, 1920, pp. 1349-1354, 4 figs. Method of treating low-grade copper sulphide ores. Shallow type of pneumatic flotation cells devised.

Machines

The Fahrenwald Flotation Machine, Francis A. Thomson. Min. & Sci. Press, vol. 120, no. 24, June 12, 1920, pp. 871-873, 4 figs. Machine consists of stationary hollow tube, to lower end of which upper and lower housings and enclosing impeller are suitably secured. Upper side of impeller runs in air and lower side is in contact with small fraction of pulp. This, it is said, eliminates vortical and eddying action characteristic of paddle-agitator machines.

FLYING BOATS

Design

Flying Boats—The Form and Dimensions of Their Hull, G. S. Baker. Shipbuilder, vol. 22, no. 117, May 1920, pp. 345-349, 3 figs. Curves showing effect of hull dimension on power required to overcome water resistance, sketches of typical hulls and efficiency curves for various types.

Oertz

The Oertz Flying Boats. Aerial Age, vol. 11, no. 13, June 7, 1920, pp. 440-441, 4 figs.

HAMILTON
HEAVY CASTINGS

These Are "Glass" Tables

Gigantic tables thirty feet in diameter, of gray iron, cast in sections eight to a table!

On these tables, plate glass is polished. They are difficult to cast and machine, for when the eight sections are assembled, they must fit exactly and the table must be level.

In this picture are 96 sections—12 complete tables, which is a large order for this class of work. We have made more than 100 tables.

Special foundry and machine shop facilities enable us to make and machine iron and semi-steel castings up to 130 tons each. We have the engineers to help you with your designs for heavy castings if necessary, and the skilled workmen to produce them.

Write to engineering department on new or replacement work involving heavy castings.

THE HOOVEN, OWENS, RENTSCHLER CO.
Hamilton, Ohio

ENGINEERING INDEX (Continued)

Series of flying boats designed and built by Oertz Works at Hamburg, Germany. Translated from Flugsport.

Schalk Hydromonoplane

The Schalk Hydromonoplane (Der Schalk-Wasser-Eindecker), H. Böckel. Luftfahrt, no. 1-2, Jan. 1920, pp. 17-18, 2 figs. Details of a model said to be perfect replica of the hydromonoplane of the Hansa & Brandenburg Works. A thin, oiled bond paper is used for covering, which, after receiving an enamel coating, is said to be absolutely waterproof; weight of model, 160 gr.

FORGING

Equipment

Economic Considerations in Regard to the Selection of Forging Equipment (Wirtschaftliche Gesichtspunkte bei der Wahl von Schmiedeaggregaten), H. Schneider. Der praktische Maschinen-Konstrukteur, vol. 53, nos. 2, 4 and 6, Jan. 15, 29 and Feb. 12, 1920, pp. 1-4, 12-15 and 20-24, 11 figs. Description and illustrations of steam hammers, steam hydraulic and pure hydraulic presses, with graphic charts showing kinetic energy stored in a hammer tup, pressure exerted by hammers of different sizes, maximum capacities, and operating costs of presses and hammers. (To be concluded.)

FOUNDRIES

Equipment

Many Equipment Features in Hercules Foundry, Gilbert L. Lacher. Iron Age, vol. 106, no. 3, July 15, 1920, pp. 123-130, 15 figs. Plant is equipped with three 96-in. Whiting cupolas with total daily melt of 250 to 300 tons. Buda elevating trucks operated by storage batteries are used to transport cars for pig iron, scrap, coke and facing sand.

Reclaiming Metal from Sand

Reclaiming Metal Parts from Sand, George H. Manlove. Foundry, vol. 48, no. 11, June 1, 1920, pp. 426-428, 2 figs. Thorough screening with suitable magnetic means for removing iron objects from foundry sand is said to have resulted in considerable saving to several large foundries.

[See also COST ACCOUNTING, Foundries.]

FREIGHT HANDLING

See TERMINALS, MARINE, Freight Handling.

FREQUENCY CHANGERS

Researches

Researches on Frequency Transformers, Tsunetaro Kujirai. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 5, March 30, 1920, pp. 87-143, 30 figs., partly on 16 supp. plates. Theoretical and experimental investigations of no load cores, and load cores, and of conditions of maximum volt-ampere capacity and maximum efficiency. For a given magnetic induction and current density, volt-ampere capacity is found to be maximum when copper and iron spaces are so proportioned that copper space equals five-fourths of iron space, and under this condition of maximum volt-ampere capacity maximum efficiency is said to occur when iron loss per unit volume equals copper loss per unit volume.

FROZEN-MEAT INDUSTRY

Research in

The Method and Scope of Scientific and Industrial Research, with Special Reference to the Frozen Meat Industry, A. M. Wright. Cold Storage & Ice Assn. Proc., vol. 15, 1918-1919, pp. 147-155 and (discussion) pp. 156-159.

FUELS

Liquid (Colloil)

"Colloil" Liquid Fuel. Colliery Guardian, vol. 119, no. 3097, May 7, 1920, p. 1287, 4 figs. According to described invention of G. Calvert, it is claimed that solid fuel need not be a colloidal suspension in liquid; it is maintained in suspension during handling or transference by agitation, and liquid acting as a vehicle need not be a fuel; when it is a fuel the agitation and means for handling or transferring mixture of solid and liquid fuels may be utilized to insure a properly proportioned mixture.

Liquid, Ignition Temperatures

Spontaneous Ignition-Temperatures of Liquid Fuels, Harold Moore. Jl. Instn. Petroleum Technologists & Rec. of Trans., vol. 6, no. 22, April 1920, pp. 186-211 and (discussion) pp. 211-223, 28 figs. Fuels measured by different experimenters are compared and results obtained by writer in similar experiments are quoted. Ignition points are listed for different mixtures of hydrocarbons.

Low Grade

Production and Utilization of Low-Grade Fuels (Gewinnung und Verwertung minderwertiger Brennstoffe), A. Wirth. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 15-16, Apr. 17, 1920, pp. 327-331, 25 figs. Includes description and illustrations of traveling, horizontal and hollow grates, and various types of grate bars for low-grade fuels. (Concluded.)

Lumber Refuse

Hog Fuel in the Pacific Northwest. Power, vol. 51, no. 18, May 4, 1920, pp. 709-712, 4 figs. Hog fuel is refuse from lumber made in process of manufacture into boards and pieces of larger dimensions. It consists of broken slabs and pieces broken from timber, sawdust and other forms. Performance results with hog fuel in plant of St. Paul & Tacoma Lumber Co. are included.

[See also LIGNITE; OIL FUEL; PULVERIZED COAL.]

FURNACES

White-Metal Melting Furnace

The Carle Type of White-Metal Melting Furnace (Weissmetall-Vergiessungsofen, System Carle). Motorwagen, vol. 23, no. 11, Apr. 20, 1920, pp. 183-185, 4 figs. Account of a system developed by firm of Gottlieb Carle, Mannheim, with details and illustrations of a gas melting furnace, a furnace for preheating journal brasses prior to babbitting, and a furnace for melting babbitt out of old brasses, all equipped with pyrometers.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEAT-TREATING

Rotary Hearth-Type

Rotary Oil-Fired Furnace of New Design. Iron Age, vol. 105, no. 21, May 20, 1920, pp. 1448-1450, 5 figs. Motor-driven hearth-type which makes one revolution for time required for carburizing. Results of trial operations are quoted.

FURNACES, METALLURGICAL

High-Temperature Oil-Fired

A High-Temperature Oil-Fired Laboratory Furnace, H. K. Najarian. Eng. & Min. Jl., vol. 109, no. 26, June 26, 1920, p. 1413, 2 figs. Oil burner is of pan type. Oil is not atomized by mechanical means before it is ignited. Furnace is said to have been successfully used for melting and refining of nickel, and it is claimed that by proper manipulation furnace temperatures up to 1700 to 1800 deg. cent. can be obtained with it.

G

GAGES

Optical Flat

The Optical Flat—A Practical Measuring Tool, H. L. Van Keuren. Am. Mach., vol. 53, no. 3, July 15, 1920, pp. 107-112, 8 figs. Describes optical flat and its use for shop measurements.

[See also MEASURING MACHINES, Universal.]

GALVANIZING

Schoop Process

The Schoop Process of Mass Galvanization (Die Schoopsche Massenverzinkung). Autogene Metallbearbeitung, vol. 13, no. 1, Jan. 1, 1920, pp. 4-5. Description of metal-spraying process and apparatus for galvanizing large quantities of articles in a very short time by entirely automatic operation.

Testing Coatings

A New Method of Testing Galvanized Coatings, Allerton S. Cushman. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 12 pp., 3 figs. Method depends upon placing on surface to be tested a tinned iron ring which is stoppered with soft-rubber stopper, thereby making a cell by means of which an hydrochloric acid-antimony chloride solution can be run on to the surface and resulting hydrogen formed by reaction of acid on zinc collected and measured.

GAS

Research

Third Report of the Research Sub-Committee of the Gas Investigation Committee of the Institution of Gas Engineers. Gas Jl., vol. 150, no. 2978, June 8, 1920, pp. 592-603. Subject investigated was relative efficiency of using different grades of gas.

Fourth Report of the Research Sub-Committee of the Gas Investigation Committee of the Institution of Gas Engineers. Gas Jl., vol. 150, no. 2978, June 8, 1920, pp. 604-631, 11 figs. Description of Uddingston research station, and account of work there performed.

GAS ENGINES

Carburation Requirements

Carburation Requirements of a Typical Gas Engine, P. A. Tice. Automotive Industries, vol. 42, no. 26, June 24, 1920, pp. 1452-1457, 17 figs. From work done with Hinkley 4.5 × 5.5-in. four-cylinder, overhead valve, heavy-duty engine, it was concluded that relative engine speed has little effect on fuel utilization, working cylinder pressures and carburation requirements, relative load of engine being dominant controlling factor and specific working pressures direct functions of relative vapor content of charge.

Indicator for

A New High-Speed Gas-Engine Indicator. Power, vol. 51, no. 18, May 4, 1920, pp. 720-722, 5 figs. Design developed by United States Bureau of Standards to meet special research requirements.

Large

Large Gas Engines (Grossgasmaschinen). Der praktische Maschinen-Konstrukteur, vol. 53, no. 5, Feb. 5, 1920, pp. 33-38, 7 figs. Details of large gas engine built by the Schleifmühle Machine Works.

Mine Service

The Gas Engine at the Mine. Gas Engine, vol. 22, no. 7, July 1920, pp. 222-224, 4 figs. Combined gas-engine and steam-turbine installation at Bergmannsglueck mine at Buer in Westphalia, Germany.

GAS INDUSTRY

Coal Research Work

The Results of Modern Coal Research Work in Connection with the Gas Industry (Die Ergebnisse der modernen Kohlenforschung und ihre Beziehungen zur Gasindustrie), P. Schläpfer. Feuerungstechnik, vol. 8, no. 9, Feb. 1, 1920, pp. 77-81. Notes on distillation of coal at high and at low temperature, and under pressure, extraction of coal, and effect of chemical reagents. In writer's opinion it has been shown that production of raw materials for the iron, explosives and dye industries can be best effected and with least expense by the distillation process, and the heating gas which is recovered by this process is also a valuable product.

GAS PRODUCERS

Grateless

Grateless Gas Producers, with Special Reference to Those in Which the Liquid Clinker is Tapped (Ueber rostlose Gaserzeuger, besonders mit flüssigen Schlackenabstich), Hubert Hermanns. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 17-18, May 1, 1920, pp. 351-354, 8 figs. It is pointed out that the two types of grateless producers in general use are Heller type of small producer with narrow gasification chamber, and large producer with tapping of the liquid clinker, aim of latter being the gasification of small-size waste fuel and the production of low-temperature tar.

Tar and Sulphate of Ammonia Production

The Economy of Gas-Producer Plants in the Production of Crude Tar and Sulphate of Ammonia (Ueber die Wirtschaftlichkeit von Gaserzeugungsanlagen bei Gewinnung von Urteer und schwefelsaurem Ammoniak), E. Roser and G. Klingenberg. Stahl u. Eisen, vol. 40, nos. 16 and 18, Apr. 22 and May 6, 1920, pp. 533-541 and 610-613 and (discussion) pp. 613-621, 4 figs. Debate based on previous articles by authors. Tabular data of operation and production costs are included. (To be continued.)

Thyssen

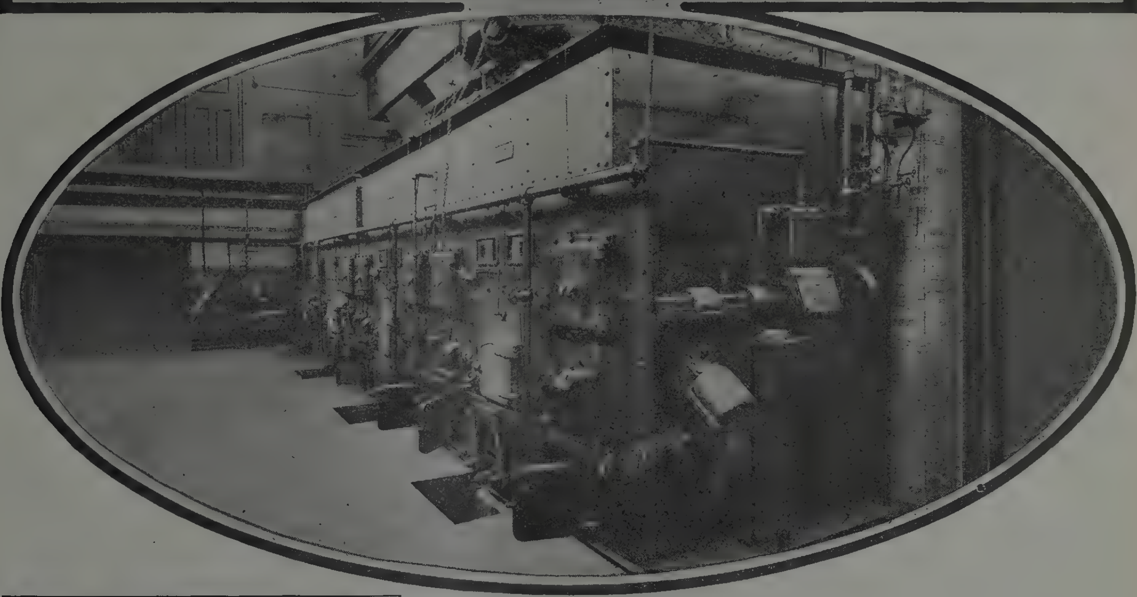
The Economy of Gas Producer Plants in the Production of Low-Temperature Tar and Sulphate of Ammonia (Die Wirtschaftlichkeit von Gaserzeugungsanlagen bei Gewinnung von Tieftemperaturteer und schwefelsauren Ammoniak), E. Roser. Stahl u. Eisen, vol. 40, nos. 11 and 12, Mar. 1 and 18-25, 1920, pp. 349-357 and 387-395, 14 figs. Discussion of cost and recovery of by-products through gasification of anthracite, lignite briquets and a mixture of the two, and economy of gasification plants in recovery of by-products is demonstrated by use of producer gas for heating and generating purposes. Description and illustrations of fifteen revolving-grate producers of the Thyssen type and tables giving heat obtained from 1 kg. of coal, cost of production of gas and other data. Report from Steel Works Committee of Assn. of German Foundrymen.

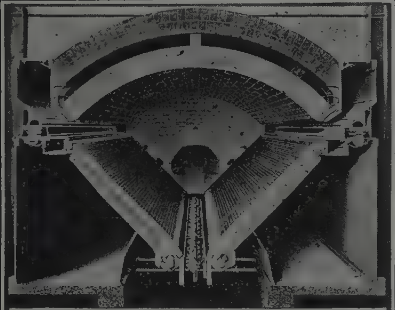
GASES

Entropy of

The Entropy of Gases, Richard C. Tolman. Jl. Am. Chem. Soc., vol. 42, no. 6, June 1920,

Economical Steam Generation





Factors Back of Every Installation of MURPHY FURNACES

Natural Draft—on everything except the most extreme peak loads. Will double the output of your boilers without one penny for draft.

Burn any fuel. This is the biggest possible feature for the engineer to consider at the present time.

Standard—The Murphy Furnace is standard in design. All new features produced from time to time may be applied to any Murphy Furnace now in use.

Smokelessness. The Murphy Furnace is designed to afford perfect combustion. The arch insures high furnace temperature which means that the air is preheated and admitted exactly where and when needed to give maximum efficiency.

Automatic Operation. The amount of fuel supplied may be regulated while in operation. Every detail for keeping a perfect fire is provided in the design and construction of the Murphy Furnace. The coal is supplied—the fire distributed evenly—the ash removed—continuously and automatically.

The Beechnut Packing Company, known to everyone as producers of pure food products, have installed at their Rochester, N. Y. plant, four Murphy Furnaces. Two of these were put in operation in 1913 and two in 1919.

They state as their reasons for using

MURPHY
AUTOMATIC
FURNACES

"That economy of operation is in line with our efforts to produce high quality at lowest operating costs and general cleanliness is in keeping with our entire plant."

Now that low priced coal is a thing of the past, economical steam generation is being sought by every power plant manager. If you want to save from 15% to 30% of your coal bill—get rid of black smoke—solve your labor problem—or increase your boiler capacity—then you should investigate the Murphy Furnace.

Our engineers are ready to co-operate.

Write for Catalog A-9

MURPHY IRON WORKS, Detroit, Michigan

BURN ANY FUEL THAT HAS HEAT IN IT

pp. 1185-1193. Comparison of experimental results for entropy of gases at one atmosphere and 298 deg. absolute, and results theoretically determined.

GASOLINE

Cracking Processes

Motor Gasoline from Heavier Hydrocarbons, Fred W. Padgett. Mech. Eng., vol. 42, no. 7, July 1920, pp. 400-402 and 426. Particulars regarding its preparation by various cracking processes, together with discussion of theory of cracking and notes on present status of industry.

[See also NATURAL GAS, Gasoline from.]

GASOLINE ENGINES

Slow-Running

The Limits of Slow Running, A. Johnson. Automobile Engr., vol. 10, no. 139, June 1920, pp. 231-232, 1 fig. Torque curve is constructed for four-cylinder engine running without load, and equations of velocities are computed from which it is found that minimum velocity on which engine can run with regularity is 145 r. p. m.

GEARS

Warpage in Heat-Treating

Discussion on Warpage of Gears During Heat Treating Operations. Proc. Steel Treating Research Soc., vol. 2, no. 11, 1920, pp. 20-24, and p. 55. Opinions expressed by various manufacturers.

GLASS MANUFACTURE

Furnaces

Glass Furnaces (Der Glasschmelzofen). Sprechasaal, vol. 53, no. 7, Feb. 12, 1920, pp. 66-67. Suggestions for reducing consumption of fuel. Of the two systems described, the recuperative and regenerative systems, the latter is said to consume less fuel and is therefore more generally used.

GLASS, OPTICAL

Weathering Tests

A Practical Test for the Resistance of Optical Glass to Weathering, F. R. v. Bichowsky. Jl. Am. Ceramic Soc., vol. 3, no. 4, April 1920, pp. 296-304 and (discussion), pp. 304-308. 1 fig. Results of weathering tests on optical glass by various methods.

GOLD METALLURGY

Ore Treatment

The La Luz and Los Angeles Mine, in Nicaragua, Jesse Scobey. Eng. & Min. Jl., vol. 110, no. 1, July 3, 1920, pp. 6-13, 6 figs. Over 11.000 tons of ore were treated in 1919. Present milling includes stamps, ball mills and classifier, amalgamation and cyanidation having been found the best practice.

GRAIN ELEVATORS

Pennsylvania Railroad

An Improved Grain Elevator for Export Service. Ry. Age, vol. 69, no. 1, July 2, 1920, pp. 9-13, 8 figs. Reinforced-concrete and structural steel structure with storage capacity of 4.257.-000 bu. There are four car unloaders and it is said that grain can be unloaded at the rate of 40 cars an hour.

GUNS

Erosion of

On Erosion of Guns, Masatosi Okôchi. Jl. College of Eng., Toyko Imperial University, vol. 9, no. 7, March 31, 1919, pp. 239-265, 6 figs. partly on suppl. plate. Survey of experiments published by various investigators and theoretical analysis of their results. Causes of gun erosion are believed to be (1) chemical action of combustion gas,—not considered serious, (2) partial melting of gun barrel owing to leakage of high temperature gas through narrow path between driving band and surface of bore, (3) cracks on surface of bore,—believed to play the most important rôle in erosion, and (4) wear of material on surface of bore owing to enormous friction produced by motion of projectile.

GYPSUM

Specifications

Report of Committee C-11 on Gypsum. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 30 pp. 1 fig. Proposed revised tentative specifications for gypsum and calcium gypsum, and proposed revised tentative methods for tests of gypsum and ground gypsum production.

H

HANDLING MATERIALS

Cost of

Cost of Handling Material, C. S. Bundesman. Indus. Management, vol. 60, no. 1, July, 1920, pp. 11-12, 5 figs. Writer claims that in many plants material control is neglected, and its costs practically unknown and urges analyzing each step in handling materials and determining cost of each operation. Records obtained in factories from these analyses are shown.

HANGARS

Reinforced-Concrete

Navy Dirigible Hangar at Lakehurst a Huge Structure. Eng. News-Rec., vol. 84, no. 19, May 6, 1920, pp. 892-897, 6 figs. Approximately 6.4 acres covered by roof arches abutting on high triangular towers. Plan is 803 x 360 ft. and arch crown 172 ft. above ground. End doors are self-supporting structures.

Wooden

A Large Wooden Hangar for Hydroplanes (Eine hölzerne Riesenhalle für Flugzeuge). Holzwelt, vol. 7. no. 12, Feb. 10, 1920, p. 6, 2 figs. Description of a large hangar in Warnemünde completed in Dec., 1919, built entirely of wood, an interesting feature of which is the door which opens in a few minutes to width of 55 m. and height of 18 m. Dimensions: Width, 55 m.; length, 160 m.; height, 31 m.

HARBORS

See WAVES, Force of.

HEAT TREATMENT

See STEEL, HEAT TREATMENT OF.

HEATING AND VENTILATION

Research

Research Work in Heating and Ventilating Engineering. Ironmonger, vol. 61, no. 2429, June 5, 1920, pp. 92-93. Report of Conference called by Council of Institution of Heating and Ventilating Engineers, and attended by delegates from Royal Institution of British Architects, the Institute of Builders, Electrical Research Committee, the Institution of Gas Engineers, the Society of British Gas Industries, the British Electrical and Allied Manufacturers' Association, the Association of Engineers-in-Charge, and a Representative from Department of Scientific and Industrial Research.

HEATING, STEAM

Central-Station

The Great Central Heating Stations in Germany (Enquête sur les grandes centrales thermiques en Allemagne), Henry Dieterlen. Chaleur et Industrie, no. 2, Apr. 1920. pp. 85-92, 3 figs. Processes and apparatus employed for removing gas from boiler feedwater. (Continuation of serial.)

HEAVY-OIL ENGINES

Ingersoll-Rand

The New Ingersoll-Rand Stationary Engine. Gas Engine, vol. 22, no. 7, July 1920, pp. 201-205, 13 figs. Vertical multi-cylinder single-acting four-cycle type, having automatic ignition with low compression.

Liquid Fuel, Application of

The Application of Liquid Fuel to Heavy-Oil Engines, A. J. Wilson. Jl. Instn. Petroleum Technologists & Rec. of Trans., vol. 6, no. 22, April 1920. pp. 141-165 and (discussion), pp. 165-185, 16 figs. Compilation of data published in technical papers.

HOSE

Steam

Construction of Steam Hose, John M. Bierer. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 6 pp. From experiments made it was concluded that steam hose with seamless tube is superior in endurance to hose with tube built up in piles, and that steam hose with its fabric element a simple duck of several sufficient plies is superior in endurance to, and practically as good in contraction and expansion as, a hose made of less plies of duck supplemented by plies of braiding.

HOUSING

Industrial, Examples of

Company Housing in Anthracite Region of Pennsylvania, Leifur Magnusson. Monthly Labor Rev., vol. 10, no. 5, May 1920, pp. 186-195, 5 figs. Based on survey by Bureau of Labor of 6853 dwellings. Types of houses used are described and data is given in reference to cost of maintenance, administration, etc.

Home Owning Plan of Corporation is Popular. Iron Age, vol. 105, no. 25, June 17, 1920, pp. 1730-1732. 8 figs. Types of houses being built for employees by United States Steel Corporation.

HYDRAULICS

Research

The Need for an Endowed American Hydraulic Laboratory, Clemens Herschel. Eng. News-Rec., vol. 84, no. 26, June 24, 1920, pp. 1239-1241. In paper on "An Improved Form of Weir for Gaging in Open Channels," presented by writer before The American Society of Mechanical Engineers, he gave illustrations of need of better hydraulic testing facilities and presented arguments for a great hydraulic laboratory. He makes further comments in present paper.

HYDROCHLORIC ACID

Production

The production of Hydrochloric Acid from Chlorine and Water, H. D. Gibbs. Jl. Indus. & Eng. Chem., vol. 12, no. 6, June 1920, pp. 538-541, 3 figs. It is shown from results of experiments that reaction between clorine, water, and charcoal between zero and about 130 deg. cent., produces hydrogen chloride and carbon dioxide, and that most important factors influencing speed of reaction are character of charcoal, temperature, and relation between concentrations of water and chlorine.

HYDROELECTRIC DEVELOPMENTS

U. S., Data on

Development of National Water-Power Resources—II. Elec. Rev. (Chicago), vol. 76, no. 25, June 19, 1920, pp. 1009-1014, 3 figs. Discussion and compilation of data presented in report of Water-Power Development Committee of Nat. Elec. Light Assn. at its recent convention.

HYDROELECTRIC PLANTS

California

Progress of Power Industry in Far West, Frank G. Baum. Elec. World, vol. 75, no. 21, May 22, 1920, pp. 1189-1195, 11 figs. Location and storage characteristics of undeveloped primary water-power sites in California totaling 3000 hp. Plans for future development of these sites, covering engineering features and need of favorable legislation.

France

Hydro-Electric Plants of French System, Lucien A. H. Pahin. Elec. World, vol. 75, no. 25, June 19, 1920, pp. 1411-1413, 4 figs. Two stations, one supplying 15,000 kw. and another supplying 26,000 kw., were rushed to completion for war purposes. Five power stations will be ultimately developed. Power is employed for operating electrified section of Midi Ry. across Pyrenees Mountains between France and Spain.

Interconnection of

Interconnection in Southern Vermont. Elec. World, vol. 76, no. 1, July 3, 1920, pp. 9-12. Records of savings in fuel and water by interconnection of hydroelectric sources in southern Vermont.

Korea

Construction of Suribong Power Project in Korea, O. W. Peterson. Jl. of Electricity, vol. 44, no. 12, June 15, 1920, pp. 595-598, 6 figs. Over-pour masonry diversion dam of heavy gravity type, 650 ft. long and 34 ft. high, with foundations extending 15 ft. below low water level of Kuran River, and diversion tunnel 12 ft. x 12 ft. in section and 955 ft. long, are principal features of development.

Silt Disposal

Silt Disposal at Tacoma Hydro-Electric Plant, Llewellyn Evans. Power, vol. 51, no. 18, May 4, 1920, pp. 694-697, 6 figs. Development consists of 50-ft. concrete dam diverting water across bend in river with 10,000-ft. tunnel.

[See also RESERVOIRS; WATER POWER.]

I

ICE PLANTS

Concrete Freezing Tanks

Constructing a Concrete Freezing Tank, W. A. Darter. Power Plant Eng., vol. 24, no. 13, July 1, 1920, pp. 665-666, 2 figs. Method of utilizing old steel tanks as forms in making new concrete tanks.

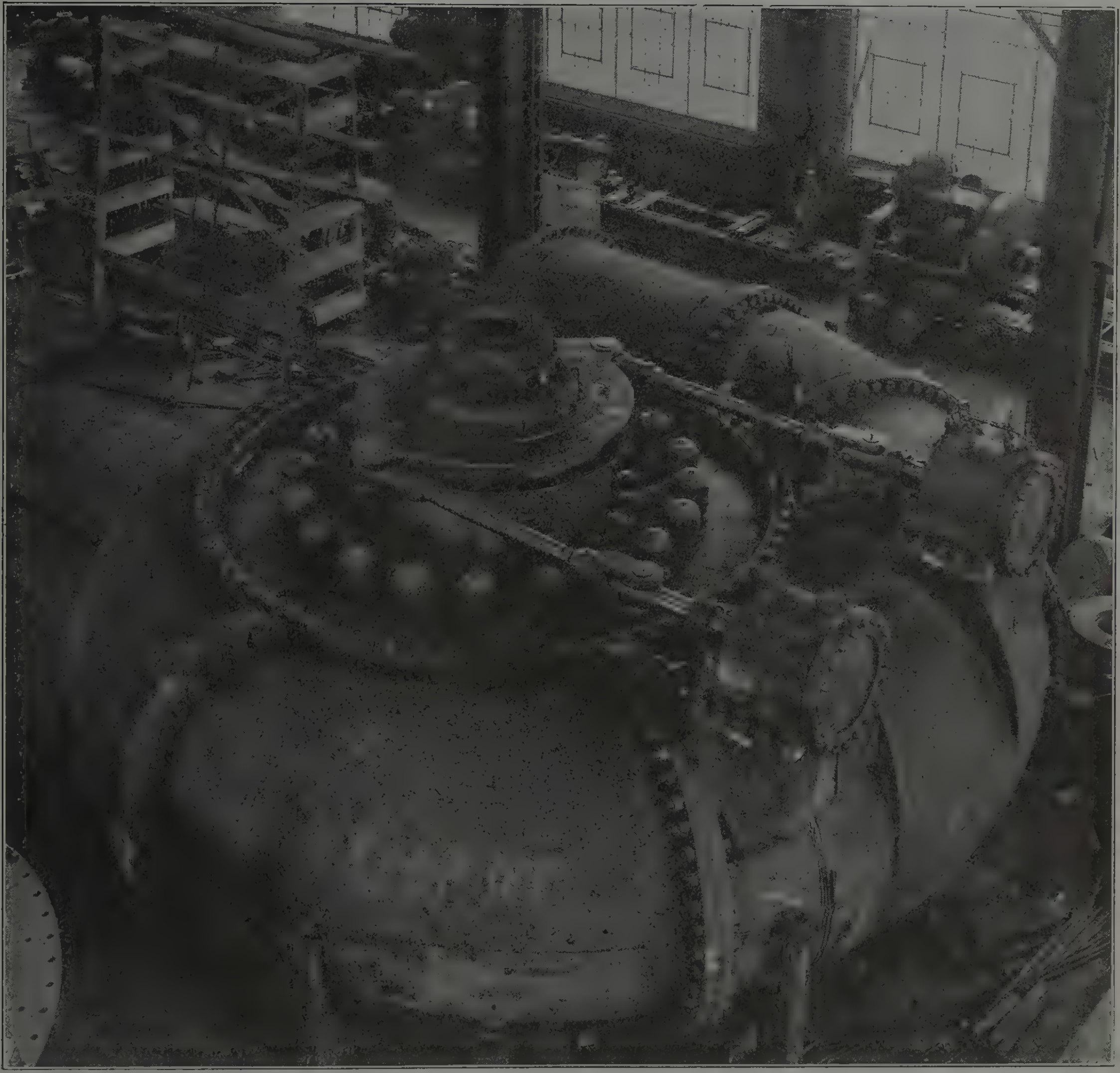
Storage Capacity

Determining Advantageous Ice Storage Capacity, F. E. Matthews. Am. Soc. Refrig. Engrs. Jl., vol. 6, no. 3, Nov. 1919, pp. 196-200, 2 figs. Construction of graph representing storage and sale for entire year. Paper read before Eastern Ice Manufacturers' Assn.

I. P. Morris Hydraulic Turbines

The Wm. Cramp & Sons Ship & Engine Building Co.

Richmond and Norris Sts., Philadelphia



Two 37,500 Horse-Power Turbines built for the Hydraulic Plant of the Niagara Falls Power Co.

Three 55,000 Horse-Power Turbines are now under construction for the Niagara Development of the Hydro-Electric Power Commission of Ontario. These turbines are of the same type as above shown and will be the most powerful units ever built.

This Company is now building Johnson Valves for the Larner-Johnson Valve & Engineering Company

INDUCTION COILS

Air-Core

The Design of Air-Core Inductance Coils of Minimum Weight for a Given Inductance and Resistance. C. O. Gibbon. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 660-665, 2 figs. General outline of theory. It is determined that reluctance of total magnetic path is twice that of portion of path through coil, for maximum efficiency coils.

INDUSTRIAL MANAGEMENT

Great Britain

Scientific Management in Great Britain, Clarence H. Northcott. Indus. Management, vol. 60, no. 1, July 1920, pp. 57-58. Experience during eight years of firm of Hans Renold, which was one of first to institute works committees in Great Britain.

Scientific Management: A Solution of the Capital and Labour Problem, J. M. Scott-Maxwell. Jl. Instn. Elec. Engrs., vol. 58, no. 291, May 1920, pp. 329-342 and (discussion), pp. 342-376, 2 figs. It is urged that by generalization of industrial management in industry, progress of reconstruction can be accellerated in England.

Principles

The Principles of Industrial Management (Les principes de L'Organisation industrielle), Danty-LaFrance. Vie Technique & Industrielle, vol. 1, no. 3, May 1920, pp. 123-127. Industrial management, it is said, is not a science based upon mathematical principles, but rests upon faithful observations of rules and methods of procedure. Necessity of standardizing conditions of work, writing instructions and other practices is concluded.

Production Control

Shop Production-Control and Accounting Systems, A. G. Drefs. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 33-38, 3 figs. Graphical method is suggested for securing complete factory costs.

Production Systems, British

Production Methods in the British Automobile Plants, M. W. Bourdon. Automotive Industries, vol. 42, no. 26, June 24, 1920, pp. 1461-1462. Despite schedules for larger outputs English factories, it is said, generally continue pre-war methods of machining and assembling. There is, however, it is noted, greater accuracy in manufacture and greater tolerance where narrow limits are unnecessary, as for instance, in external finish.

Routing

Routing Machine Parts Through the Factory, J. A. Urquhart. Iron Age, vol. 105, no. 20, May 13, 1920, pp. 1375-1379, 9 figs. System covering ordering, planning, scheduling and dispatching in use by Brown & Sharpe Mfg. Co.

Shipyards

Industrial Organization Applied to Shipyard Management, Norman Howard. Indus. Management, vol. 60, no. 1, July 1920, pp. 38-42, 7 figs. Elements worked out as standard practice by Industrial Management Section of Emergency Fleet Corporation.

Storekeeping

Scientific Management—XIV, Henry Atkinson. Eng. & Indus. Management, vol. 3, no. 25, June 17, 1920, pp. 771-774, 3 figs. Methods of storekeeping.

[See also TIME STUDY.]

INLAND WATERWAYS

Automotive Shipments

Water Borne Transportation for Automotive Shipments, George E. Quisenberry. Automotive Industries, vol. 43, no. 1, July 1, 1920, pp. 28-30, 1 fig. Survey of possibilities of such transportation based upon experience of several companies.

Transportation Rates

Influence of Capacity of Ships Upon Transportation Rates in Canals (Influence de la capacité des bateaux sur les frais de transports par canaux), M. Galliot. Annales des Ponts et Chaussées, vol. 54, no. 1, Jan.-Feb. 1920, pp. 39-61. Procedure is suggested for calculating most economical tonnage for ships operating in canal in terms of total cost of construction, operation and maintenance of canal, total traffic it carries, etc.

INSULATORS, ELECTRIC

Suspension

Electrical Characteristics of the Suspension Insulator—II, F. W. Peek, Jr. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 623-630, 23 figs. Duties of line insulators at voltages above 100 kv. are reviewed and compared with duties imposed by lower voltages.

Unit Voltage Duties in Long Suspension Insulators, Harris J. Ryan and Henry H. Henline. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 631-636, 21 figs. Potentiometer measurements were made of maximum and average voltage duties occurring in strings made up of 10-in. cap and pin type units wherein numbers of units were varied from 2 to 20. It is concluded that suspension insulator units in common use can be satisfactorily employed for make-up of insulators for 250-kv. lines, and that static shields in requisite forms will lower maximum unit voltage duties so as to permit satisfactory insulation of lines for use of voltages far above 150 kv.

INTERNAL-COMBUSTION ENGINES

Air Filter

Air Filter for Internal-Combustion Engines (Luftfilter für Explosionsmotoren), Schmidt-Reinhau. Oel- u. Gasmaschine, vol. 17, no. 4, Apr. 1920, pp. 49-51, 2 figs. Details of the Radio air filter (Radio Apparatus Co., Ltd., Berlin), designed for economy of space in connection with its use on argricultural motor plows, which is filled with especially constructed metal rings, and has a filter surface 500 times larger than a cloth or wire filter of same size.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; CARBURETORS; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; HEAVY OIL ENGINES; OIL ENGINES.]

IONIC VALVES

Oscillations

Further Experiments on the Variation of Wave-Length of the Oscillations Generated by an Ionic Valve due to Changes in Filament Current, J. H. Vincent. Proc. Roy. Sec., series A, vol. 97, no. A683, April 15, 1920, pp. 191-196. Incidences of maximum wave-length for particular current is claimed to have been established.

IRON

Puddling Plant

New Plant Puddles Iron Mechanically. Iron Age, vol. 104, no. 22, Nov. 27, 1919, pp. 1053-1057, 12 figs. Lebanon Valley Iron & Steel Co. plant at Lebanon, Pa. Among advantages claimed for mechanical puddling is great saving of labor, which is reflected in reduced production cost. The whole plant, it is stated, with capacity for 160 tons of iron every 12 hr., will be manned by not more than 20 workers.

IRON-CARBON ALLOYS

Graphitization

On the Graphitization in Iron-Carbon Alloys, Kuniichi Tawara and Genshichi Asahara. Jl. College of Eng., Tokyo Imperial University, vol. 9, no. 6, Nov. 25, 1918, pp. 197-237, 38 figs. partly on 12 supp. plates. Various alloys with carbon content ranging from 2 to 4 per cent were cast under different conditions. Factors, such as casting temperature, temperature of mold, time and mode of cooling, were found to do nothing more than define solidifying velocity of molten metal and cooling velocity of it after solidification. It is concluded that under the same conditions the higher the temperature of a molten is, the more graphitization occurs. Graphite was produced at temperatures of 1100 deg. cent. and 1000 deg. cent., the former being the more favorable while it was not at temperature of 900 deg. cent.

IRON FOUNDING

Ingot Mold Casting

Large Ingot Mold Casting. Iron Age, vol. 105, no. 20, May 13, 1920, pp. 1365-1366, 3 figs. Molding and pouring problems in making 114-ton iron mold.

Modern Practice

How Machine Castings Are Made. Foundry, vol. 48, no. 10, May 15, 1920, pp. 379-383, 8 figs. Practice of modern foundry company. Mechanical equipment makes it possible, it is said, to produce castings conforming to severe specifications with unskilled labor.

Pouring Direct from Blast Furnace

Making Ore Pile Part of Automotive Plant, F. L. Prentiss. Iron Age, vol. 105, no. 19, May 6, 1920, pp. 1295-1302, 14 figs. partly on supp. plate. Plan of Henry Ford to pour castings direct from blast furnace.

K

KILN DRYING

See AIRCRAFT CONSTRUCTION MATERIALS.

L

LATHES

Increasing-Lead Screw Cutting

Screws with an Increasing Lead. Machy. (Lond.), vol. 16, no. 398, May 13, 1920, pp. 173-174. Lathe for machining such screws.

Line-Bearing and Flange-Turning

Wickes Crankshaft Line-Bearing and Flange-Turning Lathe, J. V. Hunter. Am. Mach., vol. 53, no. 3, July 15, 1920, pp. 99-100, 4 figs. Line of lathes specially adapted to turning line bearings and flanges on automotive crankshafts.

LEAD METALLURGY

Roasting and Smelting

Roasting and Lead-Smelting Practice at the Port Pirie (S. A.) Plant of the Broken Hill Association Smelters Proprietary, Ltd., Gilbert Rigg. Bul. of Instn. of Min. & Metallurgy, no. 188, May 1920, 15 pp. Experiments which led to adoption of double Dwight-Lloyd method.

LIGHTING

Factory

High Intensity Factory Illumination, M. A. Smilari. Iron Age, vol. 105, no. 21, May 20, 1920, pp. 1428-1431, 5 figs. Economic and social effects. Specifications for artificial sources of light. Range of intensities for various kinds of work.

Illumination Intensity

Predetermining Foot-Candle Illumination, I. W. Gross. Elec. World, vol. 75, no. 25 ,June 19, 1920, pp. 1423-1425, 2 figs. Chart for determining vertical illumination on horizontal plane at any distance below center of light from 2 ft. up to 100 ft. and along horizontal plane up to distance of 300 ft. on each side of unit.

Street

Street Lighting with Low Mounted Units. Kenisco Dam Roadway, C. A. B. Halvorson and A. B. Oday. Trans. Illuminating Eng. Soc., vol. 15, no. 3, Apr. 30, 1920, pp. 153-162, 10 figs. Specifications for units for lighting roadway on Kenisco Dam, New York City waterworks, are quoted and application of units used there to street lighting is discussed.

LIGNITE

Surface Mining

Apparatus for Handling Lignite in Surface Mining (Braunkohlenförderbahen), W. Mets. Fördertechnik u. Frachtverkehr, vol. 13, no. 1, Jan. 9, 1920, pp. 4-7, 10 figs. Describes improvements in excavating and transporting which have reduced costs of operation.

LOCOMOTIVE BOILERS

Superheater Locomotive

Locomotive Boilers. Ry. Engr., vol. 41, no. 485, June 1920, pp. 254-258, 9 figs. Sectional drawings, etc., of large boilers utilized by Lancashire and Yorkshire Ry. Co. on 0-8-0 type superheater locomotives.

LOCOMOTIVES

Auxiliaries, Air Consumption of

Air Consumption of Locomotive Auxiliaries. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 395-398, 3 figs. Cost of wasted air shown and condemning limits proposed to raise standard of maintenance. Abstract of committee report and discussion, presented at annual convention of Air Brake Assn.

Dust-Protecting Device

Dust-Protection Devices for Freight Locomotives (Staubverkleidung für Güterzugslokomotiven), Otto Hamader. Fördertechnik u. Frachtverkehr, vol. 13, no. 1, Jan. 9, 1920, pp. 7-8, 7 figs. In passing through cities locomotives often catch dust from the streets which causes damage to their mechanism and bearings; hence use of a dust protector is advised, of which several types are described.

Rebuilding

A Useful Locomotive-Rebuild. Ry. Engr., vol. 41, no. 485, June 1920, pp. 259-262, 7 figs. Illustrated description of rebuilding of class "E" express locomotive on South-Eastern & Chatham Ry., special features being small increase in weight and greatly increased efficiency.

Repair Costs

Reducing Cost of Locomotive Repairs, S. W. Mullinix. Ry. Rev., vol. 66, no. 20, May 15, 1920, pp. 795-797. Rearranging and regrouping machines, dividing shops into separate departments and other means of reducing costs. Paper read before West. Ry. Club.

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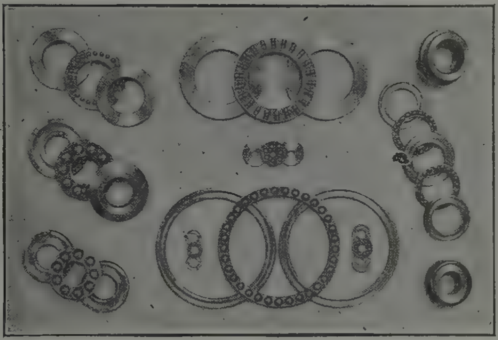

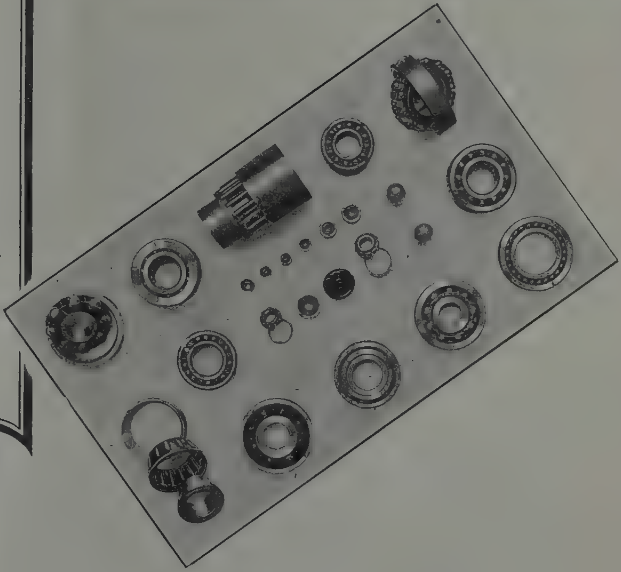

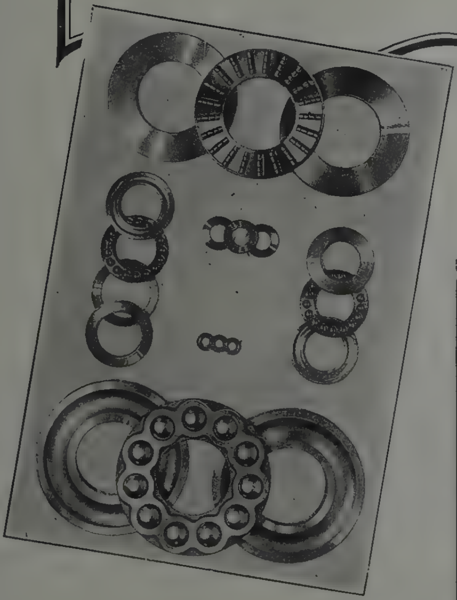

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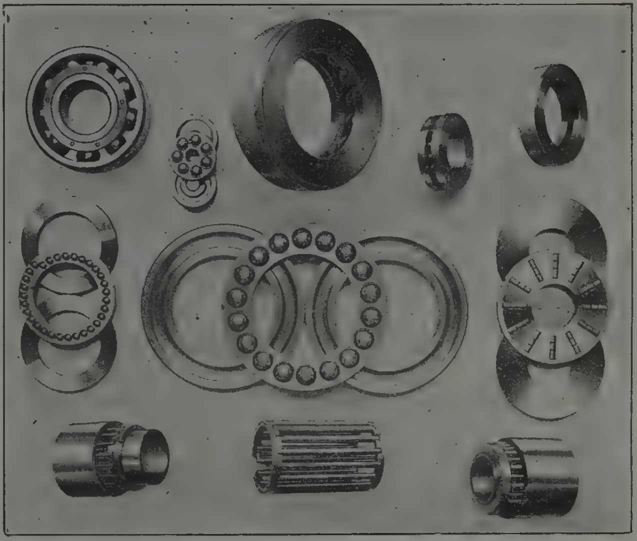

ENGINEERING INDEX (Continued)

M

MACHINE TOOLS

Railway-Shop

New Special Machines for the Machining of Rolling Stock Parts (Neue Sondermaschinen für die Bearbeitung von Eisenbahnfahrzeugteilen). Der praktische Maschinen-Konstrukteur, vol. 53, no. 2, Jan. 15, 1920, pp. 4-7, 8 figs. Describes various special machines manufactured by the machine-tool factory of H. Wagner & Co., Ltd., including special milling machine for machining car brackets, horizontal boring machine for tires, and a buffer head lathe.

MACHINERY

Power Requirements of

The Power Consumption of Machines, Hubert E. Collins. Indus. Management, vol. 60, no. 1, July, 1920, pp. 35-37. Summary of records from several plants including data on drive for screw machines.

MANGANESE STEEL

Properties

Properties of Manganese Steels, Jerome Strauss. Proc. Steel Treating Research Soc., vol. 2, no. 11, 1920, pp. 14-19 and p. 47, 8 figs. Table of elastic limits, ultimate strengths, and elongations of copper, nickel and manganese steels. By manganese steels are meant those which contain over 1 per cent manganese.

MARINE BOILERS

Water-Tube vs. Cylindrical

Water-Tube versus Cylindrical Boilers in the Mercantile Marine, A. Spyer. Steamship, vol. 31, no. 371, May 1920, pp. 257-260. Universal adoption of water-tube boilers in world's navies is pointed out. Its slow adoption in mercantile navy is attributed to difficulty of determining best type to use, necessity of fresh water feed and increased initial and maintenance cost. Paper read before Liverpool Eng. Soc.

MARINE ENGINES

Cylinder Repairs

Repairing of German Vessels Taken by Brazilian Government (Note sur les rêparations des navires allemands saisis au Brésil), G. Bourgés. Bulletin Technique du Bureau Veritas, vol. 2, no. 5, May 1920, pp. 85-89, 16 figs. Cylinders were broken by German crews. Repairing consisted of assembling broken parts and fastening them mechanically with joining pieces secured in various ways to cylinder parts. Examples are described.

[See also DIESEL ENGINES, Marine.]

MARINE STEAM TURBINES

Main Exhaust Pipes

Design of Main Exhaust Pipes for Turbines, Cyrus Hankins. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 583-586, 8 figs. Details of various types, with notes on fitting of expansion joints.

Monel-Metal Blades

Monel-Metal Blades in Destroyer Turbines, W. F. Rice. Power, vol. 51, no. 23, June 8, 1920, pp. 908-911, 8 figs. Bethlehem Shipbuilding Corporation put into service during last two years upward of 100 destroyers, all of which were fitted with monel turbine blading. It is stated that in no case has monel blading been found to be in bad condition.

MEASURING INSTRUMENTS

Torque Meter

New Apparatus for the Control of Machine Operation (Einiges über neuzeitliche Betriebskontrolle), R. Uhlmann. Der praktische Maschinen-Konstrukteur, vol. 53, no. 4, Jan. 29, 1920, pp. 9-12, 3 figs. Benzinger's torque meter, an apparatus which accurately records the load over a given period on the machine to which it is attached.

Universal

A Universal Measuring Machine. Am. Mach., vol. 53, no. 2, July 8, 1920, pp. 49-53, 14 figs. Construction and method of operation of machine designed for accurate measurement of pieces of all shapes. Machine is intended as primary standard of measurement for use chiefly in making and checking gages. It has been made for some time in Switzerland, although it is said to be a new machine to this country.

MERCURY

Determination in Organic Matter

The Determination of Mercury, C. M. Bouton and L. H. Duschak. Dept. of Interior, Bur. of Mines, Paper 227, 1920, 44 pp. 7 figs. Method developed by Bur. of Mines for use in study of mercury condenser losses, and especially for determination of minute amounts of mercury associated with organic matter.

METALLOGRAPHY

Instruments Adapted to

The Microscope as Used in the Study of Metals, W. L. Patterson. Proc. Steel Treating Research Soc., vol. 2, no. 11, 1920, pp. 26-37, 27 figs. Instruments best adopted to metallography.

Notes on

Metallography (Metallographie), Rudolf Ruer. Physikalische Zeitschrift, vol. 21, nos, 1, 2 and 3, Jan. 1, 15 and Feb. 1, 1920, pp. 16-23, 51-55 and 74-80, 20 figs. Notes on two-substance systems. Deals with reciprocal solubility and condition of aggregate; law for lowering of congealing temperature; changes in crystalline condition, polymorphous transformations, chemical combinations, etc. (Continuation of serial.)

METALS

Fatigue of

Fatigue of Metals Under Repeated Stress, H. F. Moore and J. B. Kommers. Iron Age, vol. 105, no. 23, June 3, 1920, pp. 1595-1598, 6 figs. Also Blast Furnace & Steel Plant, vol. 8, no. 6, June 1920, pp. 368-372, 4 figs. Report of progress in investigation under joint auspices of National Research Council, Engineering Foundation and Illinois Engineering Experiment Station. It has been found that fatigue failure follows path through crystal grains themselves rather than along their boundaries. Thus primary cause of fatigue failure is said to be localized deformation. Paper read before Am. Iron and Steel Inst.

Porosity, Determination of

Apparatus for the Determination of the Porosity of Metals, F. K. Bezzenberger and R. A. Wilkins. Chem. & Metallurgical Eng., vol. 22, no. 22, June 2, 1920, pp. 1031-1032, 2 figs. Apparatus for testing ability of nonferrous castings to hold air pressure without leaking.

Substitute

Economical Substitute Metals (Betrachtungen über Sparmetalle), Albert Würth. Stahl u. Eisen, vol. 40, nos. 13 and 17, Apr. 1 and 29, 1920, pp. 421-426 and 568-575, 50 figs. It is demonstrated that for construction of Diesel engines and centrifugal pumps, as well as for valves and cocks, and especially for shell fuses, good results can be obtained by use of substitute metals, but for steel apparatus they have not proved satisfactory. Writer defines limitations in use of the substitute metals and tells how difficulties which arise can be overcome.

METEOROLOGY

Upper Air, Properties of

Characteristic Properties of Air at High Altitudes (Les propriétés charactéristiques de l'air aux hautes altitudes), A. Lapresle. Aérophile, vol. 28, nos. 5-6, March 1-15, 1920, pp. 66-71, 3 figs. Based on data obtained at Aeronautical Observatory at Lindenberg, Germany.

[See also AEROPLANES, Aerophysical Investigations with.]

MILLING MACHINES

Grinding Attachment

A Grinding Attachment for a Milling Machine, Jack Finlay. Am. Mach., vol. 53, no. 3, July 15, 1920, pp. 114-116, 3 figs. Device for grinding holes in pieces that are too long to swing in universal grinder or lathe, or so unwieldly that time required for setting up is long in comparison with that taken for grinding.

MINE HAULAGE

Ilgner Regulating System

New Flywheel Equalizers in Electric Haulage Plants (Neuere Schwungradpufferungen in elektrischen Förderanlagen), W. Wolf. Kali, vol. 13, no. 21, Nov. 1, 1919, pp. 353-356, 4 figs. Describes haulage plant with improved Ilgner flywheel regulation for winding motor, at Siemens-Schuckert Works, Ltd., near Berlin. (To be continued.)

MINE HOISTING

Coal Mines

Mine Hoisting Duty Cycles in Operation, M. A. Whiting. Coal Industry, vol. 3, no. 6, June 1920, pp. 272-277, 7 figs. Certain specific hoisting conditions in practical operation at coal mine are given as example, and results obtained in actual practice are graphically illustrated and described.

Safety Devices

Safety Devices Applied in Winding, Robert M. Metcalfe. Colliery Guardian, vol. 119, no. 3101, June 4, 1920, pp. 1572-1574, 16 figs. Paper read before South Wales Inst. of Engrs.

MINE LOCOMOTIVES

Electric

Changes that Experience has Dictated in Details of Combination Locomotives, John B. Hicks. Coal Age, vol. 18, no. 1, July 1, 1920, pp. 20-22. Devices were introduced in combination trolley and storage battery locomotives at mine of Consolidated Coal Co., Jenkins, Ky., to prevent excessive rate of charge during gassing stage, to make impossible a too complete discharge of batteries and to avoid possibility of discharging batteries into trolley circuits.

Gasoline

Operation of Gasoline Locomotives in Coal Mines (Essais de traction par locomotives a benzine), M. Dessemond. Bul. et Comptes rendus mensuels de la Société de l'Industrie Minérale, vol. 17, no. 2, March-April 1920, pp. 145-150. Tests made at Saint-Etienne collieries with a view to determine quantity of air required to be circulated through mine and cost of operating such locomotives.

MINE RESCUE WORK

Aeroplanes in

Use of Airplanes in Mine Rescue Work, F. J. Bailey. Monthly Reports of Investigations, Bur. of Mines, Dept. of Interior, April 1920. 3 pp. Preliminary survey of Bur. of Mines has indicated "that airplane service might be effectively utilized in the flat-lying coal-fields of Illinois and Indiana."

MINES

Drainage with Air Lift

Air Lift for Mine Drainage, S. F. Shaw. Eng. & Min. Jl., vol. 109, no. 23, June 5, 1920, pp. 1263-1268, 9 figs. Practical data and detailed description of installation in Mexico. Theoretical quantity of air required by lift. Details of footpiece, discharge box, and measuring weir.

Lighting and Eyesight

Lighting Conditions in Mines, with Special Reference to the Eyesight of Miners, T. Lister Llewellyn. Illuminating Engr., vol. 13, no. 3, March 1920, pp. 67-79 and (discussion). pp. 80-102, 9 figs. It is said that nystagmus is common in all safety lamp pits and rare in candle pits. Standard of illumination based on this fact is suggested of one-tenth of a foot-candle over whole working area.

The Influence of Conditions of Illumination Upon the Eyesight of Workers in Coal and Metalliferous Mines. Illuminating Engr., vol. 13, no. 3, March 1920, pp. 103-106. Examinations of miners at metal and coal mines in Belgium have disclosed the fact that workers operating by inadequate illumination from safety lamps showed notable proportion (more than 10 per cent) of cases of nystagmus, whereas workers in same category receiving light for more than one year from incandescent electric lamps (32 candlepower) showed no signs of nystagmus.

[See also GAS ENGINES, Mine Service.]

MINING

Management in

How Shall We Get Mining Efficiency? Edwin H. Higgins. Eng. & Min. Jl., vol. 109, no. 26, June 26, 1920, pp. 1398-1406. List of materials requiring systematic attention on the part of mine managers and superintendents, and approved method of systematic observations and administration.

Ontario

Recent Developments in Mining in Northern Ontario, James G. McMillan. Can. Min. Inst. Bul., no. 97, May 1920, pp. 377-386. Comparison of conditions in gold and silver mines in 1914-1915 with those of 1920.

MOLYBDENUM

Determination of

The Application of the Rotating Zinc Reductor in the Determination of Molybdenum, Walter Scott. Jl. Indus. & Eng. Chem., vol. 12, no. 6, June 1920, pp. 578-580. Experiments in which molybdic acid in dilute sulphuric acid was reduced by rotating zinc cylinder both with and without aid of electrolytic current.

MOLYBDENUM STEEL

Calcium Molybdate Additions

Calcium Molybdate as an Addition Agent in Steel Making, Alan Kissock. Chem. & Metallurgical Eng., vol. 22, no. 22, June 2, 1920, pp. 1018-1020. Best results are said to be secured by introducing molybdate immediately

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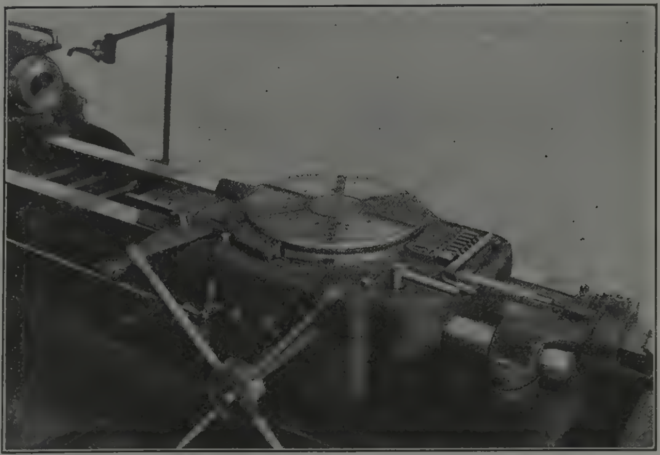

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SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

after skimming of first, or phosphorous slag, white slag indicating that reduction has been complete. In open-hearth practice it is necessary that molybdate be added in early stages of heat, preferably just before melt becomes "level."

MOTOR BUSES

New York

Motor-Bus Transportation, G. A. Green. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 67-74, 1 fig. Organization of Fifth Avenue Coach Co., New York.

Operation

The Place of the Bus—V, Walter Jackson. Elec. Ry. Jl., vol. 56, no. 1, July 3, 1920, pp. 11-15, 2 figs. Laws relating to motor-bus operation in existence in various States and cities.

MOTOR PLOWS

German

New Motor Plows at the Exhibition of the German Agricultural Society 1919 (Neue Motorpflüge auf der Ausstellung der Deutschen Landwirtschaftsgesellschaft 1919), Gustav Fischer. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 13-14, Apr. 3, 1920, pp. 294-298, 20 figs. Description of more important types of motor plows exhibited in Magdeburg, including the Delma, Hansa-Lloyd, Benz-Sending, Podeus, Büssing and other models. Most noteworthy progress said to be shown in development of caterpillar tractors.

The Benz-Sending Motor Plow (Der Benz-Sending-Motorpflug). Oel- u. Gasmaschine, vol. 17, no. 3, Mar. 1920, pp. 33-36, 2 figs. Tractor type of motor plow with single-wheel drive, advantages of which are said to be its simple construction combined with safety in operation, easy manipulation even by unskilled workmen, light weight of engine and resulting saving in fuel consumption, etc.

Lecler

Farm Machinery (La motoculture), F. Mirés. Vie Technique & Industrielle, vol. 1, no. 3, May 1920, pp. 104-108, 5 figs. Description of Lecler plow. (Continuation of serial..

MOTOR-TRUCK TRAFFIC

California

Freighting with Motor Trucks on Kern River Project No. 3. Eng. News-Rec., vol. 84, no. 19, Apr. 29, 1920, pp. 868-869, 2 figs. Experience gained in delivering 28,000 tons of freight to California job over a 50-mile haul on mountain roads.

MOTOR TRUCKS

Engines

A Heavy-Duty High-Speed Engine, Otis E. Griner and Mark A. Smith. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 89-95, 11 figs. Universal truck and tractor engine designed by Midwest Engine Co. It is a four-cylinder, four-cycle vertical valve-in-head engine, with bore of 4½ in. and stroke of 6 in. Records of tests are included.

Tests

A Study of Road Impact and Spring and Tire Deflection, A. F. Masury. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 96-98 and (discussion), pp. 98-102. Account of tests performed with various models of motor trucks to determine effect of different spring and tire equipment on impact and effect of unsprung weight upon road impact, as well as effect of varying speed on these impacts.

Transmission Gears

Gear Teeth Sizes from the Standpoint of Durability—II, Joseph Jandasek. Automotive Industries, vol. 42, no. 25, June 17, 1920, pp. 1402-1406, 4 figs. It is claimed that calculations of gear teeth should be based on resistance of wear of teeth and not, as is customary, on breaking strength of teeth.

MOTORCYCLES

French Designs

The Recent Development of Motorcycles in France, W. F. Bradley. Automotive Industries, vol. 42, no. 25, June 17, 1920, pp. 1394-1396, 9 figs. Construction features of several of recent French models.

MOTORSHIPS

Diesel-Engined

New Vickers-Engined Motorship. Motorship, vol. 5, no. 7, July 1920, pp. 609-615, 7 figs. Dimensions: Displacement, 14,000 tons; fuel capacity, 750 tons; cruising radius, 68 days; total cargo capacity, 486,000 cu. ft.; length, 425 ft.; breadth, molded, 56 ft.; 8 in.; depth, molded, 33 ft.; draft, 26 ft.; contract speed, 10.5 knots; trial speed (on 26 ft., 2 in. draft), 11.24 knots.

N

NATURAL GAS

Gasoline from

Gasoline from Natural Gas. I—Method of Removal, R. P. Anderson, Jl. Indus. & Eng. Chem., vol. 12, no. 6, June 1920, pp. 547-549, 1 fig. Principles forming foundation of compression, refrigeration and absorption methods for production of gasoline from natural gas are enunciated and relationships between different methods are explained. Table of properties of principal gasoline constituents and curves indicating vapor pressures of some of these hydrocarbons at different temperature are included.

Gasoline Removal, Effect of

Effects of Gasoline Removal on the Heating Value of Natural Gas, Donald B. Dow. Dept. of Interior, Bur. of Mines, technical paper 253, 1920, 23 pp. 2 figs. Loss in B. t. u. value in "dry gas" ordinarily supplied to domestic consumer was found to be about 2 per cent after gasoline vapor had been removed, but for "casing-head" gas percentage loss was found to be larger.

NAVAL AIRCRAFT

United States

U. S. Naval Aircraft, Jerome C. Hunsaker. Jl. Franklin Inst., vol. 189, no. 6, June 1920, pp. 715-736, 12 figs. Types used,

NICKEL

Rolled Shapes

Rolled Products of 99 Per cent Nickel, Edwin F. Cone. Iron Age, vol. 105, no. 25, June 17, 1920, pp. 1713-1716, 9 figs. Open-hearth treatment which makes possible rolling of same shapes now produced in mild steel.

NICKEL-CHROME STEEL

Brittleness

Brittleness in Nickel-Chrome and Other Steels,—II, F. Rogers. Annual Meeting, Iron & Steel Inst., May 6 & 7, 1920, 5 pp. 2 figs. Heating and cooling curves constructed from data obtained experimentally. First paper was published in Jl. Iron & Steel Inst., no. 2, 1919, pp. 325-328.

NICKEL PLATING

See ALUMINUM ALLOYS, Nickel Plating.

NITROGEN

Absorption of Oxides by Nitric Acid

On the Absorption of Oxides of Nitrogen by Nitric Acid, Eric K. Rideal. Jl. Indus. & Eng. Chem., vol. 12, no. 6, June 1920, pp. 531-538, 7 figs. It is concluded from results obtained in experiments that rate of absorption of nitrogen dioxide by water and nitric acid solutions follows a monomolecular law. It is believed that production of strong nitric acid may be accomplished by process of refrigeration of a gas mixure containing suitable proportions of nitrogen, dioxide, water vapor and oxygen.

Extraction from Atmosphere

Distillation of Liquid Air and Separation of Gas from Atmosphere (La distillation de l'air liquide et la séparation des gaz de l'atmosphére), P. Pollard. Vie Technique & Industrielle, vol. 1, no. 3, May 1920, pp. 114-117, 2 figs. Georges Claude process of extracting nitrogen from atmosphere.

NON-FERROUS METALS

Specifications

Report of Committee B-2 on Non-Ferrous Metals and Alloys. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 33 pp. Revised specifications for copper bars for locomotive staybolts, and for aluminum ingots for remelting and rolling; also revised methods for chemical analysis of alloys of lead, tin, antimony and copper.

O

OFFICE MANAGEMENT

Principles

Getting the Office Work Done—I, Wallace Clark. Indus. Management, vol. 60, no. 1, July 1920, pp. 13-16, 3 figs. Application of principles of industrial management to organization and management of offices.

OIL

See PETROLEUM.

OIL ENGINES

Steinbecker Solid-Injection

The Steinbecker Solid-Injection Engine. Motorship, vol. 5, no. 7, July 1920, pp. 625-626, 3 figs. Constant-pressure oil engine, built by German Automobile Construction Co., Ltd., Berlin, and Hanover Machine Co. (To be continued.)

[See also DIESEL ENGINES; HEAVY-OIL ENGINES.]

OIL FIELDS

Valuation

The Classification of Undeveloped Oil Lands for Purposes of Valuation, Carl H. Beal. Economic Geology, vol. 15, no. 4, June 1920, pp. 315-327, 1 fig. Based on answers to questionnaire sent to geologists and petroleum engineers requesting their views on tentative definitions.

OIL FUEL

Burning

Recent Developments in the Design of Oil-Burning Furnaces (Les plus récents procédés de chauffage au mazout), G. Lechartier. Technique Moderne, vol. 12, no. 3, Mar. 1920, pp. 116-123, 25 figs. Attention is directed to adaptation to oil-burning of boilers built to burn coal. One installation in Berlin and another in Rotterdam are described. Results of service tests of various classes of oil fuels conducted at works of Smith Dock Co., North Shields, England, are quoted.

Economy

Economies Obtained in Burning Oil, Robert Sibley and C. H. Delany. Elec. World, vol. 75, no. 26, June 26, 1920, pp. 1483-1484. Results obtained at three Arizona plants.

Industrial Demand

Industrial Demand for Oil as a Fuel, George Otis Smith. Blast Furnace & Steel Plant, vol. 8, no. 6, June 1920, pp. 365-367. It is stated that first three months of 1920 have established rate of domestic production that if unchecked will reach a total of 415,000,000 barrels. Paper read before Am. Iron & Steel Inst.

OPEN-HEARTH FURNACES

France

The Tilting Open Hearth's Future in France. Iron Age, vol. 105, no. 22, May 27, 1920, pp. 1499-1500. Superiority of basic open-hearth steel over basic bessemer steel is pointed out and increasingly large demand in Europe for former kind of material is noted. Translated from Revue de Métallurgie.

Gas-Fired

The Heating of Open-Hearth Furnaces with Lignite Producer Gas (Die Beheizung von Martinöfen mit Braunkohlengeneratorgas), Stahl u. Eisen, vol. 40, no. 17, Apr. 29, 1920, pp. 565-567 and (discussion), pp. 567-568. It is pointed out that in gasification of briquets in producers, special attention should be given to clinker, and addition of steam is necessary to insure good quality of gas and to maintain an even, not too high temperature, which is also necessary for production of tar. Report from steelworks committee of Assn. German Foundrymen.

The Heating of Open-Hearth Furnaces with a Mixture of Blast-Furnace and Coke-Oven Gases (Ueber die Beheizung von Martinöfen mit einem Gemisch aus Hochofen- und Koksotengas), Adolf Schneider. Stahl u, Eisen, vol. 40, no. 15, Apr. 15, 1920, pp. 501-506 and (discussion), pp. 506-510, 2 figs. Description of a patented process of the Dortmund Union for production of carbon steels and alloyed special steels in tilting open-hearth furnaces by use of a mixture of low-grade and high-grade gas. In this process the bath is heated to such an extent that a slag of such high basicity and reaction capacity is formed that phosphorus and sulphur enter into it and through dumping of slag, are almost entirely removed without reduction of carbon content and without loss of the additions of chromium, nickel, wolfram, etc. Report from Steelwork Committee of Assn. German Foundrymen.

OSCILLATIONS

See IONIC VALVES, Oscillations.

OSCILLOGRAPHS

Portable

Portable Oscillograph, J. W. Legg. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 674-679 9 figs. Lamp and film motor are operated from small transformer which may be plugged into any ordinary lamp socket or power supply of approximately 110 or 220 volts at any frequency from 20 to 70 cycles.

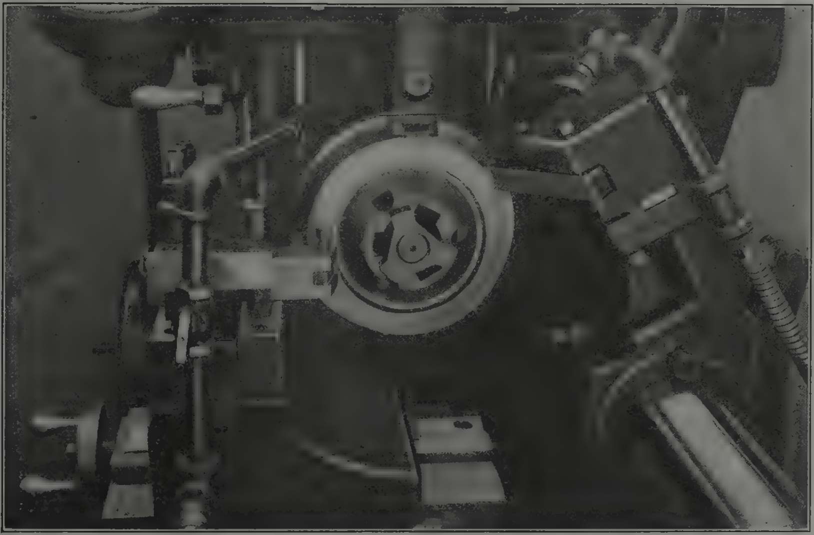
OXY-ACETYLENE CUTTING

Developments

Recent Developments in Oxygen Cutting, Stuart Plumley and F. J. Napolitan. Iron Age, vol. 105, no. 22, May 27, 1920, pp. 1505-1506, 1 fig. Development quoted as most in-

FAY AUTOMATIC LATHE

Second Operation on Ring Gear



The Fay Automatic Ring Bevel Gear Lathe equipped for second setting on Ring Bevel Gears.

The gear is held on a fixture locating from the back and the finished hole.

The Front Carriage carries tools for finishing the short bevels at each end of the teeth.

The Back Arm carries tools for roughing the face of the gear.

An overhead angular tool slide carries a finishing tool held on a separate holder, making it possible to take a finish cut without being affected by the action of the roughing tool held in the back arm.

The finishing tool follows closely behind the roughing tool so that the gear may be roughed and finished complete in about the time required to pass a tool across the face.

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Australasia—McPherson's Pty, Ltd., 554 Collins St., Melbourne

SEE OUR DATA IN 1919 A.S.M.E CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT teresting which has occurred recently is successful cutting of cast iron. Theory and principles of oxy-acetylene cutting of cast iron are discussed.

OXY-ACETYLENE WELDING

Engine Bedplate

Oxyacetylene Promptly Clears Shaft and Repairs Engine Bed after an Overwind. Charles C. Phelps. Coal Age, vol. 17, no. 23, June 3, 1920, pp. 1131-1134, 9 figs. As result of overwind, bedplate of hoisting engine was broken and its foundation bolts were sheared. Two bailing buckets, several hundred feet of rope and an 8-in. pipe were wedged together at botton of shaft. Repairs were made by means of oxyacetylene torch.

Pipe Mains

Oxy-Acetylene Welding of Pipe Mains, Alfred S. Kinsey. Welding Engr., vol. 5, no. 6, June 1920, pp. 30-32, and p. 38, 4 figs. Method of welding joints on top of ditch and turning pipe to meet convenience of welder is said to be most efficient and economical.

Torch Carriage

A New Carriage for Welding Torches (Ein neues Fahrgestell für Schweissbrenner). Autogene Metallbearbeitung, vol. 13, no. 1, Jan. 1, 1920, pp. 7-9, 2 figs. Description and illustrations of a patented device consisting of a fork-like carriage with two wheels, whose connecting axle carries a socket for the attachment of the torch, by use of which it is possible, without any change of position between torch and surface of plate, to effect a more or less close approach to workpiece.

P

PARACHUTES

Stability

Stability of the Parachute and Helicopter, H. Bateman. Nat. Advisory Committee for Aeronautics, report no. 80, 1920, 11 p. Mathematical theory.

PAVEMENTS, ASPHALT

Asphalt-Cement Specifications

Asphalt Cement Qualities and Tests Needed in Specifications for Sheet Asphalt and Asphalt Concrete Pavements, J. W. Howard. Mun. & County Eng., vol. 58, no. 6, June 1920, pp. 236-237. Qualities recommended to be specified include ductility, specific gravity, penetration and freedom from volatile oil.

PAVEMENTS, ASPHALTIC CONCRETE

Merits of

The Merits of Asphaltic Concrete Pavements, W. H. Connell. Contract Rec., vol. 34, no. 25, June 23, 1920, pp. 603-605. Importance of properly maintaining asphaltic concrete roads in order to get maximum service from them is pointed out. As instance of successful maintenance, Grand Boulevard and concourse of New York City, built in 1910 and still in perfect condition, is indicated.

PAVEMENTS, BITUMINOUS

Construction Methods

Bituminous Paving Suggestions, Theodor S. Oxholm. Public Works, vol. 48, no. 18, May 15, 1920, pp. 425-426, 1 fig. Corrugating base to prevent creeping of asphalt surface, use of old macadam as base, softness of asphalt that gives best results, and laying next to rails.

PETROLEUM

Consumption in U. S.

The Industrial Demand for Oil and the Available Supply, George Otis Smith. Automotive Industries, vol. 42, no. 25, June 17, 1920, pp. 1419-1421. Warning is issued that rate of consumption of oil in United States exceeds rate of production. Total consumption for year at present rate would be 490,000,000 bbl., while production is expected to be 415,000,000 bbl.

Resources of U. S.

Industry's Need of Oil, George Otis Smith. Iron Age, vol. 105, no. 23, June 3, 1920, pp. 1584-1586. Warning is issued that oil demand in United States is now in excess of supply. First three months of 1920, it is said, have established rate of domestic production that if unchecked will mean 415,000,000 bbl. for year, and rate of consumption that will make year's requirements more than 490,000,000 bbl. Paper read before Am. Iron and Steel Inst.

PETROLEUM INDUSTRY

Details of

The Petroleum Industry (L'industrie du pétrole), H. Pouleur. Revue universelle des Mines, vol. 3, no. 1, Sept.-Oct. 1919, pp. 1-71. Composition of raw oil is taken up, together with its transportation, its storage, and processes of distilling it. Products of distillation are classified, and properties and uses of each explained.

PHOSPHORUS

Determination in Iron, Steel, Ores and Slag

Critical Investigation of Methods of Determining Phosphorus Content in Iron, Steel, Ores and Slag (Kritische Untersuchung der Verfahren zur Bestimmung des Phosphors in Eisen, Stahl, Erzen und Schlacken). Stahl u. Eisen, vol. 40, nos. 12 and 14, Mar. 18-25 and Apr. 8, 1920, pp. 381-387 and 468-472 and (discussion) pp. 472-473. Account of experiments carried out by sub-committee of chemical committee of the Assn. of German Foundrymen, results of which are shown in tabular form.

PHOTOTELEPHONY

New Apparatus for

New Apparatus for Phototelephony (Neue Apparate für Lichttelephonie), Hans Thirring. Physikalische Zeitschrift, vol. 21, no. 3, Feb. 1, 1920, pp. 67-73, 5 figs. Description of transmitting and receiving apparatus developed as result of author's experimental work in collaboration with Simon and completed by him after Simon's death.

PIERS

Concrete Roof Trusses

Precast Concrete Roof Trusses in Panama Pier Shed, Guy W. True. Eng. News-Rec., vol. 84, no. 26, June 24, 1920, pp. 1232-1238, 9 figs. Discussion of feasibility of concrete roof trusses with comparisons of cost data between two similar sheds, one with reinforced-concrete roof trusses and one of structural steel.

PILES

Sheet, Tests of

Tests of Solid and Laminated Wood Sheet-piles. Eng. News-Rec., vol. 84, no. 25, June 17, 1920, pp. 1201-1202. Tests made at Cornell University on quarter-scale models under bending loads.

PIPE, CONCRETE

Centrifugal Process

The Manufacture of Concrete Pipes by "Hume" Centrifugal Process, W. Wolstenholme. Jl. South African Instn. Engrs., vol. 18, no. 10, May 1920, pp. 175-181 and (discussion) pp. 181-184, 8 figs. Process at factory of Hume Pipe Co., Germiston, South Africa.

PIPE, DRAIN

Tests

Supporting Strength of Drain Tile and Sewer Pipe Under Different Pipe-Laying Conditions, W. J. Schlick. Iowa State College of Agriculture & Mechanic Arts Official Publication, vol. 18, no. 46, April 14, 1920, 68 pp., 26 figs. It was determined that supporting strength of pipe in ditch depends quite largely upon area of foundation to which load on pipe is transmitted and uniformity of distribution of pressure over this area. Factor of safety of 1¼ was found to be both necessary and sufficient to prevent cracking. Pipe-laying methods are classified into "ordinary," "first class" and "impermissible." Supporting strength of pipe laid according to each of these methods was determined.

PLIOTRONS

See VACUUM TUBES, Pliotron.

POLARIMETERS

Half-Shade

The Theory of the Half-Shade Polarimeters (Zur Theorie der Halbschatten-Polarimeter), Hans Schulz. Physikalische Zeitschrift, vol. 21, no. 2, Jan. 15, 1920, pp. 33-38, 1 fig. Writer explains that there are two classes of half-shade polarimeters, those producing a strictly linear polarized light, and those capable of emitting elliptical polarized light. A source of error common to both classes is described, namely, the influence of the inclination of ray of light toward axis of apparatus. Report from the C. P. Goerz Optical Works, Berlin-Friedenau.

POTASH

Kelp Distillation

Potash from Kelp. II—The Experimental Distillation of Kelp at Low Temperatures, G. C. Spencer. Jl. Indus. & Eng. Chem., vol. 12, no. 7, July 1920, pp. 682-684, 1 fig. Sixteen distillations of dried kelp made in oil-jacketed wood retort at temperatures not exceeding 320 deg. cent. yielded, it is said, aqueous liquor, tar, and non-inflammable gas. Residual charcoal is believed to have been insufficiently heated either for good extraction of potash or for use as filtering medium.

POWER

Development in United States

A Study of Power Development and Suggestions for Future Progress, L. W. W. Morrow. Power, vol. 51, no. 23, June 8, 1920, pp. 922-924, 4 figs. Charts showing growth of annual coal consumption, horsepower used in manufacture, and central stations in United States.

POWER FACTOR

Variations

Variations of Power Factor in Terms of Variations of Active Component (Les variations du facteur de puissance en fonction des variations de la composante active), P. Rieunier. Revue générale de l'Électricité, vol. 7, no. 23, June 5, 1920, pp. 755-768, 7 figs. Analytical study of general formula. (Concluded.)

POWER GENERATION

Gas vs. Electricity

Note on the Thermal Efficiency of the Generation and Use of Gas and Electricity, Dugald Clerk. Gas Jl., vol. 150, no. 2980, June 22, 1920, pp. 778-782. Discussion of figures given as relative thermal efficiencies of gas and electricity in generation, distribution, and use for heat, power, and light, in diagram published in Gas Journal, Feb. 10, 1920, p. 295. According to those figures ultimate efficiency of gas for heating is much greater than that of electricity; for producing motive power, efficiency is greater by gas than by electricity; and for producing light, advantage is in favor of electricity.

PRESSES

Guard for

A Simple and Effective Press Guard, Leroy W. Allison. Am. Mach., vol. 52, no. 25, June 17, 1920, pp. 1303-1304, 1 fig. Describes guard used in connection with the Sheridan press, consisting of perforated or expanded metal sheets attached to machine both on "operating" and "take-away" sides, permitting operator feeding press to insert leather under guard, and preventing attendant on "take-away" side from removing leather until it protrudes from under guard.

PRODUCTION

Comparative, Test of

Interesting Test of Comparative Production. Iron Age, vol. 105, no. 22, May 27, 1920, p. 1513. Employees of American Multigraph Co., Cleveland, have proposed through their representatives to management to put out as large product in eight hours as in nine or return to old schedule. Experiment is now being conducted and results will be determined in six months.

PROJECTILES

Pressure Distribution on Shell Heads

The Pressure Distribution on the Head of a Shell Moving at High Velocities, L. Bairstow, R. H. Fowler, and D. R. Hartree. Proc. Roy. Soc., vol. 97, no. A684, May 1, 1920, pp. 202-218, 4 figs. Experimental. Pressures were measured by using service time fuses as manometers. Preliminary laboratory experiments were performed to determine extent to which rate of burning of a service time fuse was affected by total external pressure on vents.

Shell Flight, Dynamics of

The Dynamics of Shell Flight, R. H. Fowler. Nature, vol. 105, no. 2641, June 10, 1920, pp. 459-461, 2 figs. Survey of researches during war, particularly in regard to accepted theory accounting for drift of shell.

PROPELLERS, SHIP

Low-Powered Merchant Ships

Propellers for Low-Powered Merchant Ships, S. M. Robinson. Jl. Am. Soc. Naval Engrs., vol. 32, no. 2, May 1920, pp. 237-241, 2 figs. Chart is constructed which gives required horsepower for various propeller diameters.

PUBLIC UTILITIES

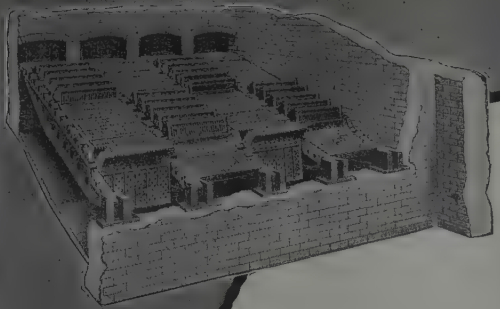
Valuation

Valuation of Public Utilities, F. W. Ballard. Jl. Cleveland Eng. Soc., vol. 12, nos. 2 and 3, Sept.-Nov. 1919, pp. 147-154 and (discussion) pp. 154-159. Determination of "fair value" for rate-making purposes.

PULVERIZED COAL

Comparison with Stokers

Pulverized Coal Versus Stokers for Boilers. Iron Age, vol. 105, no. 26, June 24, 1920, pp. 1798-1800. Comparison of equipment and op-



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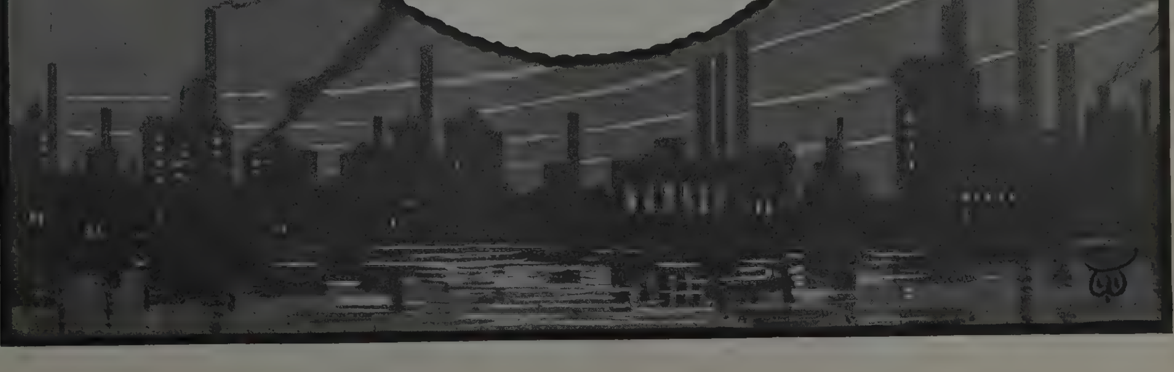


erating costs. Factors to be considered in converting existing plant.

Distributing Systems

Pulverized Coal Distributing Systems, Joseph F. Shadgen. Iron Age, vol. 105, no. 21, May 20, 1920, pp. 1423-1426. Coal powder and its characteristics. Storage and feeding devices. Pneumatic transportation by suspension, pressure and emulsion methods.

Equipment, Test of

Test of Pulverized Fuel Equipment, John Anderson. Combustion, vol. 3, no. 1, July 1920, pp. 17-21, 1 fig. Tabulated results obtained in tests performed at Oneida Street plant of Milwaukee Elec. Ry. & Light Co.

PUMPS

Air-Lift

St. Louis Tunnels Unwatered by Air Lift, Edward E. Wall. Eng. News-Rec., vol. 84, no. 18, Apr. 29, 1920, pp. 857-859, 12 figs. Installation of two-stage air lift with capacity of 3000-4000 gal. per min. and maximum head of 76 ft. It is said that difficulties were experienced with other types of pumps.

PUMPS, CENTRIFUGAL

Impellers

Researches on the Theory of the Action of Centrifugal Pump Impellers, Otogorô Miyagi. Technology Reports of the Tôhoku Imperial University, Sendai, Japan, vol. 1, no. 1, 100 pp., 24 figs. Mathematical study.

[See also WATER WORKS, Centrifugal Pumps.]

R

RADIOTELEGRAPHY

Amplifiers

Reciprocal or Reversible Amplifiers (Amplificateurs réciproques ou réversibles). Bulletin de la Société française des électriciens, vol. 9, no. 84, Dec. 1919. pp. 589-600, 14 figs. Schemes of various patented apparatus are illustrated and their operation explained.

Sending Device, Automatic

Automatic Sending Device Installed in the Alipur Observatory, Calcutta, for Sending the International Time Signals from the 30 K. W. Calcutta Radio Station. Radio Rev., vol. 1, no. 9, June 1920, pp. 432-434, 3 figs. on supp. plate. Device consists of wheel, 10 in. in diameter, rotated uniformly at speed of 1 r.p.m. through worm gearing by phonic motor driven by vibrating reed, and carrying on its periphery brass contact strips let into ebonite.

Subterranean Receiving Antenna

The Use of Ground Wires at Remote Control Stations, A. Holt Taylor and A. Crossley. Proc. Inst. Radio Engrs., vol. 8, no. 3, June 1920, pp. 171-192, 9 figs. It is stated that by utilizing subterranean receiving antenna, it has been proven possible to install receiving stations in immediate vicinity of transmitting stations. Design of underground antennæ, construction of shielded rooms for receiving sets, and mode of "remotely" controlling nearby transmitting station are described. Lay-out and installation of several such Naval "remote" control stations is given.

Waves, Electric

Refraction of Electric Waves, T. L. Eckersley. Radio Rev., vol. 1, no. 9, June 1920, pp. 421-428, 6 figs. Confirmation is presented of existence of systematic bending of rays crossing coast line, and it is shown that this "bending" behaves as if it were due to a "refraction" on account of different wave velocities over sea and land. Further observations are cited establishing this point and agreeing with theory of propagation of electric waves over land given by Zenneck, Hack, Sommerfeld and others.

RADIOTELEPHONY

Aeroplane

Wireless Telephony on Aeroplanes, C. E. Prince. Jl. Instn. Elec. Engrs., vol. 58, no. 291, May 1920, pp. 377-384 and (discussion) pp. 384-390, 6 figs. Method of Roy. Air Force.

Simultaneous Transmission and Reception

Simultaneous Transmission and Reception in Radio Telephony, Noboru Marumo. Proc. Inst. Radio Engrs., vol. 8, no. 3, June 1920, pp. 199-219, 14 figs. After reviewing methods of duplex radio communications previously proposed, writer describes a divided-branch antenna arrangement with supplementary balancing coil, for this purpose. Theory and mode of adjustment of system are explained. Application of this method in practice to ship-to-shore radiotelephony is analyzed, and reference is made to necessary wire-to-radio and reverse transfers.

RADIUM

Crystallizing

Crystallization of a Radium-Barium Solution, Clarence E. Scholl. Jl. Am. Chem. Soc., vol. 42, no. 5, May 1920, pp. 889-896, 5 figs. Several systems of crystallizing radium-barium solution are given with modified form that is said to be very efficient in crystallizing high-grade radium. Bromide system was found in experiment to be more efficient than chloride system.

Genesis from Uranium

The Relative Activity of Radium and the Uranium with which it is in Radioactive Equilibrium, J. H. L. Johnstone and B. B. Boltwood. Am. Jl. of Sci., vol. 50, no. 295, July, 1920, pp. 1-19, 3 figs. Results obtained indicate that if activity of uranium is taken as unity, activity of radium is equal to approximately 0.49. Total activity of uranium mixed with equilibrium quantities of its disintegration products is compared with activity of uranium alone, and former is found to be 4.73 times the latter.

RAILS

Basic Open-Hearth Steel

Basic Open-Hearth Steel Rails, Cecil J. Allen. Ry. Engr., vol. 41, no. 485, June 1920, pp. 243-245. Notes on their composition and properties and discussion on analysis of various casts.

Pipeless Products from Annular Blooms

Pipeless Rolled Products from Annular Blooms, C. A. Witter. Iron Age, vol. 105, no. 23, June 3, 1920, pp. 1593-1595, 3 figs. Proposed method of making rails from individual ingots.

Titanium-Treated

Service Results with Titanium-Treated Rail. Ry. Maintenance Engr., vol. 16, no. 5, May 1920, pp. 197-198. Statistics showing that failures for titanium-treated open-hearth steel rails in service have been 48 per cent of average for untreated open-hearth, and those for titanium-treated bessemer only 21 per cent of those for untreated bessemer. From Bul. 81 of Rail Committee of Am. Ry. Eng. Assn.

RAILWAY MANAGEMENT

See COST ACCOUNTING, Railway.

RAILWAY MAINTENANCE

Inspection of Freight Equipment

The Inspection of Freight Equipment. L. K. Sillcox. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 369-373. Maintenance of trucks, lubrication and packing of journal boxes, defects of wheels and axles. Sixth of series of articles.

Rolling Stock

Railroads Need Modern Machine Tools, Roy V. Wright. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 359-362, 3 figs. It is urged that more critical and scientific attention be given to upkeep of cars and locomotives. Address given before Nat. Machine Tool Builders' Assn.

RAILWAY OPERATION

Freight Handling

The Flow of Freight Through Transit Sheds, H. McL. Harding. Eng. World, vol. 17, no. 1, July 1920, pp. 9-10. It is emphasized that a constant flow of freight should be maintained by relieving floor congestion by overhead cranes, tractors and trailer hoists, especially for transverse movements and for assorting, distributing and tiering, and using surface tractors and trailers for longitudinal movements beyond range of crane hooks.

RAILWAY SWITCHES

Electric Snow Melter

Facilitating Switch Movements in Winter. Ry. Maintenance Engr., vol. 16, no. 5, May 1920, pp. 189-190, 3 figs. Electric snow melter made up of simple heat unit encased in waterproof cast-iron box measuring 15⅞ in. x 5 in. x 3¾ in.

RAILWAY TIES

Production of

Many Influences Now Affecting Tie Production. Ry. Maintenance Engr., vol. 16, no. 5, May 1920, pp. 191-197. Disturbances in long-established methods, new specifications and threat of strike among timber workers are said to restrain output.

RAILWAY TRACK

Maintenance

Note on the Life, Renewal and Depreciation of Permanent Way Material, A. Perey. Bul. Int. Ry. Assn., vol. 2, no. 5, May 1920, pp. 245-271, 2 figs. Data obtained by Swiss railways in regard to cost of maintenance and amortization, comparative service given by different classes of material and with a view to establishing within close limits increasing expense of maintenance of proposed line in accordance with various peculiar features of its construction. Translated from Bulletin technique de la Suisse romande.

RAILWAYS

Embankments

Embankment Filling Without Trestles. Ry. Rev., vol. 66, no. 26, June 26, 1920, pp. 1093-1096, 6 figs. Description of building up embankments from low level with spreader plows, on dumps of Hull-Rust Mine, Oliver Iron Mining Co., Hibbing, Minn.

South America

Railway Equipment in South America, J. P. Risque. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 364-368, 13 figs. About 65 per cent of roads are owned and controlled by British capital and operated by British nationals. Equipment used is generally of British type.

Traction on Heavy Gradients

Traction on Heavy Gradients by Means of Auxiliary Adhesion, Ch. Dantin. Bul. Int. Ry. Assn., vol. 2, no. 5, May 1920, pp. 272-284, 11 figs. Use of Hanscotte system for haulage of artillery trains. Translated from Genie Civil.

RECTIFIERS

Mechanical

Mechanical Alternating-Current Rectifiers (Le redressement des courants alternatifs par des appareils mécaniques), Alfred Soulier. Revue générale de l'Électricité, vol. 7, no. 19, May 8, 1920, pp. 619-625, 10 figs. Apparatus designed by writer.

Mercury-Vapor

The Glass Type of Mercury Vapor-Arc Rectifier, Its Theory and Practical Operation (Der Quecksilberdampf-Gleichrichter der Glastype, seine Theorie und Praktische Ausführung), Fritz Kleeberg. Elektrotechnische Zeitschrift, vol. 41, nos. 9 and 10, Feb. 26 and Mar. 4, 1920, pp. 171-173 and 193-197, 17 figs. Results of experiments for cooling glass structures in an artificial air current are said to show a 200 per cent improvement in load capacity. It is demonstrated that, with aid of proper connection of choking coils, the rectifier can be adapted to any desired conditions. Address before Electrotechnical Assn., Berlin. (Concluded.)

REFRACTORIES

Research Committee Report

Report of Refractory Materials Research Committee. Gas Jl., vol. 150, no. 2978, June 8, 1920, pp. 576-583, 2 figs. Committee report of Instn. of Gas Engrs. Experiments are described which were performed to ascertain conditions required for successful casting of refractory ware containing high percentage of grog. Comparative tests were also reported of machine-made and hand-made silica bricks. Measured specific heats of various refractory materials at high temperatures are included.

REFRIGERATING PLANTS

Ammonia-Compression

Two Indirect Methods of Finding the Weight of Ammonia in Circulation in Compression Refrigeration, J. W. Gavett, Jr. Power, vol. 51, no. 26, June 29, 1920, pp. 1042-1045, 6 figs. Non-mechanical methods of computing weight of ammonia by means of pressure-volume charts and temperature-entropy charts of ammonia cycle.

Ammonia Leaks

Testing for Ammonia Leaks in Refrigerating Plants, B. E. Hill. Power, vol. 51, no. 24, June 15, 1920, pp. 955-956. Directions for testing for ammonia leaks with phenolphthalein and sulphur sticks.

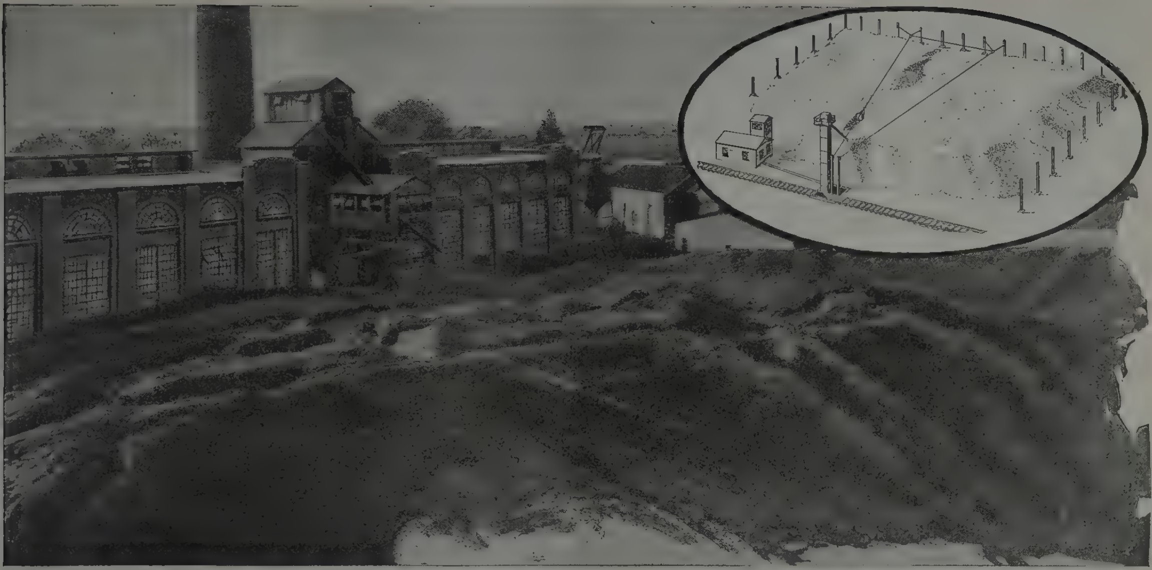
Three-Unit

Power and Refrigeration for Model Ice Cream and Dairy Plant. Power, vol. 51, no. 19, May 11, 1920, pp. 752-757, 9 figs. Modern 450-ton three-unit refrigerating plant using high-speed two-cylinder ammonia compressors, cross-connected so that either cylinder may be used on high or low-temperature service. Power and lighting are supplied by a 450-kw. electric generating condensing plant, the cooling water being conserved by large cooling tower on roof of building.

REFRIGERATION

Ethyl Chloride

Properties of Ethyl Chloride, G. C. Hodgson and Albert Henning. Refrig. World, vol. 55,



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(2 contracts)
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In determining the most efficient system of coal storage for your plant, give sufficient consideration to the labor element that enters into the operation of the storage system. A system that requires a licensed engineer or skilled operator is actually a liability, because such men are expensive and not readily replaced if they quit for one cause or another.

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The advisability of buying coal during the slack season, and having it shipped in before the railroads get tied up with moving crops and severe weather, requires no argument. The Beaumont book "Cable Drag Scraper Systems for Storing Coal" gives further evidence of the wisdom of selecting this economical and dependable system. Send for it.

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Coal and Ash Handling Systems for Boiler Houses

332 Arch Street
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no. 6, June 1920, pp. 16-18 and p. 26. Table giving results of two-ton Clothel refrigerating machine is included.

Research in

Education and Research in the Refrigerating Industry, J. Wemyss Anderson. Proc. Cold Storage & Ice Assn., vol. 14, 1917, pp. 5-15 and (discussion), pp. 16-30. Suggests that Cold Storage & Ice Assn. petition Government to subsidize Association Internationale du Froid, foster research and approve formation of Schools of Refrigeration.

RESEARCH

Briquetting Plant

Experimental Briquetting Plant, Albert L. Stillman. Chem. & Metallurgical Eng., vol. 22, no. 22, June 2, 1920, pp. 1035-1038, 4 figs. Outline of briquetting research work in General Briquetting Co.'s experimental plant.

Governmental Coöperation in

The Economic Importance of the Scientific Work of the Government, E. B. Rosa. Jl. Washington Acad. of Science, vol. 10, no. 12, June 19, 1920, pp. 341-382, 3 figs. Benefits resulting to the public from governmental coöperation in industrial research are pointed out. Reasonableness of Government assisting and leading in research work is determined from analysis of present national budget, in which only one per cent of total is dedicated to research, education and development of municipal work. Government, it is concluded, should coöperate with industries in peace as earnestly and as effectively as industries coöperated with it in war.

Photobibliographic Methods

Photobibliographic Research Methods—The Compilation of Technical Data with the Aid of Photography, Arthur Worischek. Jl. Indus. & Eng. Chem., vol. 12, no. 7, July, 1920, pp. 679-682, 2 figs. Need for portable and cheaply operated photographic device for copying illustrations and articles on file in reference libraries is pointed out. It is believed that a device combining operating principles of existing bromide paper copying machines and self-illuminated meter-reading cameras would prove to be valuable aid in data compilation and simple enough in operation for use by non-technical clerical assistants.

Tables, Preparation of

The Rapid Preparation of Tables, J. C. Witt. Jl. Indus. & Eng. Chem., vol. 12, no. 6, June 1920, pp. 591-592. Illustrates simplification of computation of results obtained in laboratory tests by constructing expression indicating progressional value of series.

[See also CHEMISTRY, Research in; ELECTRICAL ENGINEERING, Research Problems; FROZEN-MEAT INDUSTRY, Research in; GAS, Research; GAS INDUSTRY, Coal Research Work; HEATING AND VENTILATION, Research; HYDRAULICS, Research; REFRIGERATION, Research in.]

RESERVOIRS

North Carolina

Master Storage Reservoir for Southern Power Company's System, W. S. Lee and Richard Pfaehler. Elec. World, vol. 75, no. 23, June 5, 1920, pp. 1299-1303, 10 figs. Features of Bridgewater reservoir which provides storage for seven hydroelectric plants of Southern Power Co. and details of 25,000 kva. Bridgewater Station at this reservoir.

Volume Determination

Determination of Volume of Dam Reservoirs for Hydraulic Plants (Die Bestimmung des Stauinhaltes bei Talsperren für Wasserkraftanlagen), Johannes Wörner. Zeitschrift für das gesamte Turbinenwesen, vol. 17, no. 4, Feb. 10, 1920, pp. 44-46, 3 figs. Gives diagrams and works out illustrative calculations.

RIFLE BARRELS

Physical Properties

Physical Properties in Rolled Rifle Barrels, F. L. Moister. Chem. & Metallurgical Eng., vol. 22, no. 22, June 2, 1920, pp. 1025-1026, 3 figs. Tests are said to have confirmed theory that as reductions increase and temperatures decrease the tensile strength and elastic limit are increased proportionately.

RIVETED JOINTS

Tests

Experiments on Riveted Joints, James Montgomerie. Shipbuilder, vol. 22, no. 117, May 1920, pp. 335-338. Experiments undertaken at Proving House in Glasgow at instance of Committee of Lloyd's Register of Shipping.

ROAD CONSTRUCTION

Georgia Contract Form

Georgia's New Road Contract. Public Works, vol. 48, no. 23, June 19, 1920, pp. 534-536. Form which State Highway Department is intending to try out, involving estimate by contractor and fee or profit varying inversely as actual cost.

ROAD MATERIALS

Oils, Asphalt Content of

The So-Called Asphalt Content of Road Oils, B. A. Anderton and D. G. Taylor. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 7 pp. 1 fig. Investigation of Bur. of Public Roads of value of determining asphalt of 100 penetration in road oils in differentiating between various types and consistencies of oils. As a general conclusion, it is believed that percentage of asphalt gives no information on suitability of a road oil for a given purpose that is not adequately indicated by other well standardized tests.

ROADS, CONCRETE

California

Reinforcing Concrete Pavements on California Highways. Eng. News-Rec., vol. 84, no. 26, June 24, 1920, p. 1255, 1 fig. Transverse bars used to prevent cracks from widening and to maintain surface continuity.

Proportioning Aggregates

New Ideas Applied to Cement Concrete Roads, W. P. Near. Contract Rec., vol. 34, no. 25, June 23, 1920, pp. 605-608. Abrams' table of proportions and quantities for one cubic yard of concrete, based on laboratory investigations. Suggestions in regard to specification for consistency. Paper read before Canadian Good Roads Congress.

ROCK

Deval Abrasion Test

The Standard Deval Abrasion Test for Rock, F. H. Jackson. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 14 pp. 6 figs. Results of tests made in laboratory of Bur. of Public Roads in connection with proposed changes in Deval abrasion test for rock. It is concluded that results of standard Deval abrasion test as conducted in usual way are accurate to within one per cent.

ROCK DRILLS

Hammer, Hose Fittings for

Standardization of Hose Fittings for Hammer Rock Drills, George H. Gilman. Eng. & Min. Jl., vol. 109, no. 23, June 5, 1920, pp. 1252-1255, 18 figs. Conical joint, standard pipe threads, and use of heat-treated steel are suggested.

ROLLING MILLS

Electrically Driven

A Modern Bar Mill at Pittsburg, California. Iron Age, vol. 105, no. 26, June 24, 1920, pp. 1779-1782, 6 figs. Motor-driven 18-in. and 12-in. stands for production of bars and small shapes, in part for export trade.

Power Drives

Power Drives for Rolling Mills, W. O. Rogers. Power, vol. 51, no. 24, June 15, 1920, pp. 962-966, 5 figs. Several types of mills are described, together with details regarding process in rolling steel into various products, from ingot into slabs, billets, skelp, plates and pipes.

Sheet

Bethlehem's Sheet and Tin Plate Mills. Iron Age, vol. 105, no. 21, May 20, 1920, pp. 1433-1435, 1 fig. Description of arrangement and equipment of sheet mills, together with account of enlarged tin plate department of Maryland plant.

Wider Sheet Bars Advocated, Clement F. Poppleton. Iron Age, vol. 105, no. 20, May 13, 1920, pp. 1359-1363, 4 figs. Matter of balanced rigging in stands. Economies calculated and two layouts shown by way of illustrations.

Ship-Plate

The Dominion Iron and Steel Company's New Ship-Plate Rolling Mill, H. E. Rice. Can. Min. Inst. Bul., no. 97, May 1920, pp. 367-377, 5 figs. Mill is a 110-in. x 36-in. three-high plate mill of Lauth type. It consists of one stand of rolls served by tilting tables and is driven by 4000-hp. 82-r.p.m. motor through set of cut herringbone pinions.

ROOF TRUSSES

See PIERS, Concrete Roof Trusses.

RUBBER

Analysis

A Direct Method for the Determination of Rubber Hydrocarbon in Raw and Vulcanized Rubber, W. K. Lewis and W. H. McAdams. Jl. Indus. & Eng. Chem., vol. 12, no. 7, July 1920, pp. 673-676, 1 fig. Working with filtered carbon tetrachloride solution of acetone-extracted plantation pale crêpe, it is said to have been shown by a volumetric method involving a double titration that bromine consumption, corrected for observed substitution, is true measure of pure rubber hydrocarbon present.

Stress-Strain Curve

Some Aspects of the Rubber Stress-Strain Curve, William B. Wiegand. Can. Chem. Jl., vol. 4, no. 6, June 1920, pp. 160-170, 21 figs. Survey of researches made by various investigators.

RUBBER INDUSTRY

Machinery for

New Machinery in the Rubber Industry (Neue Maschinen für die Kautschuk-Industrie). Gummi-Zeitung, vol. 34, nos. 16 and 17, Jan. 16 and 23, 1920, pp. 325-327 and 350-352, 10 figs. Description of various apparatus manufactured by Werner & Pfleiderer, Cannstatt-Stuttgart, including automatic rubber kneading machine and washing machines; a kneading and mixing machine with tipping trough and double casing for beating and cooling; a hydraulic filter press for the filtration of the finished rubber solution, etc.

S

SCALES

Grain-Hopper, Errors in

Errors in Grain Hopper Scale, C. A. Briggs. Scale Jl., vol. 6, no. 8, May 10, 1920, pp. 7-9 and p. 11, 8 figs. Results of tests at Bur. of Standards.

Specifications

Scale Manufacturers' Standard Specifications for Grain Hopper Scales. Scale Jl., vol. 6, no. 8, May 10, 1920, pp. 10-11. Specifications adopted by scale manufacturers.

Track

A New Track Scale, L. R. Boyer. Ry. Rev., vol. 66, no. 20, May 15, 1920, pp. 799-801, 4 figs. Type developed according to specifications adopted by Am. Ry. Eng. Assn., The Railroad & Warehouse Commission of Minnesota, The Nat. Scale Men's Assn., The Bur. of Standards and The Scale Manufacturers' Assn.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

See MACHINERY, Power Requirements of.

SEA WALLS

Concrete Facing for

Concrete Facing Placed on Old Masonry Sea Wall. Eng. News-Rec., vol. 84, no. 21, May 20, 1920, pp. 996-998, 6 figs. West Indian store quay wall protected against underwash and erosion by precast pile and slab structure.

SEAPLANES

Hull Design

Design of the Hull of a Seaplane (Étude sur les coques d'hydravions), Maurice Blanchard. Aérophile, vol. 28, nos. 7 & 8, April 1 & 15, 1920, pp. 98-103, 18 figs. Suitabilities of different shapes.

SEARCHLIGHTS

Military

Military Searchlights, Chester Lichtenberg. Trans. of Illuminating Eng. Soc., vol. 15, no. 1, Feb 10, 1920, pp. 1-18, 37 figs. Types developed during war.

SELENIUM

Uses

Selenium and Tellurium, Victor Lenher. Jl. Indus. & Eng. Chem., vol. 12, no. 6, June 1920, pp. 597-598. Uses in iron and steel industries, glass manufacture, medicines and rubber and dye industries. Report of Committee of Nat. Research Council presented to Am. Chem. Soc.

SEWAGE DISPOSAL

Activated Sludge Plants

Milwaukee's Activated Sludge Plant. Public Works, vol. 48, no. 23, June 19, 1920, pp. 536-538. Results of five years' experiments conducted by city.

Direct Oxidation Process

A New Method of Sewage Disposal. Nat. Lime Assn., bul. no. 200, 1920, 16 pp., 1 fig. Direct oxidation process for treatment of municipal sewage. Method consists of electrochemical treatment with lime.

A Large Manufacturing Plant —12 Years—and Rex Chain

Because of its long life and dependability, thousands of feet of Rex Griplock Chain are used for elevator and conveyor service in the big Bevo plant of the Anheuser-Busch Company at St. Louis.

Ninety per cent of all chain at the Bevo plant is Rex —four of the five contractors who bid on the job specified Rex. This speaks for the wide recognition of Rex quality.

In the old brewing plant of this company are many Rex Griplock Chain conveyors and elevators which have given 10, 12 and 15 years' service.

For instance, one inclined elevator, fitted with Rex Griplock, has been working at an important point 8 hours a day, 10 months a year, for 12 years. Chief Millwright Janne believes it still has many years of equally satisfactory service in reserve.

In many industries, on elevators and conveyors of every type and size, Rex Chain is giving steady, profitable service—guarding against costly shutdowns and delays, saving labor and speeding production. It can do the same for you.

REX CHAIN

Rex Traveling Water Screens, Rex Concrete Mixers and Pavers, Rex Sprockets, Rex Elevators and Conveyors

CHAIN BELT COMPANY, MILWAUKEE

Branch Offices and Representatives in Principal Cities in the United States and Abroad

One of the Rex Griplock Chain Conveyors which has given twelve years' service in the Anheuser-Busch plant at St. Louis

SHELL MANUFACTURE

Drawing Press

Locomotive Used as a Shell Press. Eng., vol. 109, no. 2824, Feb. 13, 1920, p. 214, 9 figs. Buffer beam of engine was replaced by a much stronger one, built up of plates and sections, and fitted, in front of cylinder utilized for drawing-down operations, with the die holder, a kind of casing open at the side for inserting the dies one after another. Work was done at Bordeaux works of South of France Railway Co. Translated from Proc. Société des Ingénieurs Civils de France.

SHIP CONSTRUCTION

Fuel-Oil Tanks, Testing

Testing the Hull Structure of Ships—II, F. K. Ruprecht. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 603-606. Rules and methods for testing tanks used for carrying fuel oil.

Multiple Punching Machines, Use of

The Use of Multiple Punching Machines in the Construction of Longitudinally Framed Ships (Beitrag zur Anwendung der Vielfachlochmaschine beim Bau von Längsspantenschiffen), Gustav Schulze. Schiffbau, vol. 21, no. 23, Apr. 28, 1920, pp. 640-642, 2 figs. The riveting of a tanker is described and illustrated to demonstrate how difficulties of the varying rivet pitches in the separate longitudinal joints can be overcome.

Simplification

Simplification in the Construction of Large Ships (Beiträge zur Vereinfachung des praktischen Grossschiffbaues), W. Schrader. Schiffbau, vol. 21, no. 24, May 5, 1920, pp. 657-663, 5 figs. It is shown that in the construction of large ships, a great simplification can be effected by using a standard rivet pitch of 80 mm. for two rivet diameters of 19 mm. and 22 mm., especially for ships of simple structure. Other suggestions for simplification are also mentioned.

SHIP DESIGN

Bulkheads

Bulkheads, C. H. Peabody. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 566-568. Report of British committee on bulkheads, their location and construction and provision of strength, presented at International Convention on Safety of Ships at Sea.

Cargo Ships

Systematic Experiments with Cargo-Ship Models (Systematische Versuche mit Handelsschiffsmodellen), H. Schaffran. Schiffbau, vol. 21, no. 19-20, Mar. 31-Apr. 7, 1920, pp. 561-567, 8 figs. Results of experiments are said to show that in the case of full-shaped freight steamers of given main dimensions with long parallel midships, with the elongation of the latter and with increase of displacement degree of fineness above a certain limit, a very sudden decrease in efficiency takes place, which is explained by fact that with increase of degree of fineness not only an increase of resistance takes place, but a considerable deterioration in propeller efficiency as well. Results are shown in diagrammatic curves.

Metacenter Height

Relation of Beam to Height of Metacenter, F. M. Hiatt. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 569-572, 8 figs. partly on 2 supp. plates. Curves for determining quickly height of metacenter above base, from any combination of dimensions and form coefficients.

SHIP PROPULSION, ELECTRIC

Transmission Scheme

Electric Propulsion of Ships (La propulsion électrique des navires), Marcel de Coninck. Technique Moderne, vol. 12, no. 2, Feb. 1920, pp. 76-80, 6 figs. Scheme is indicated for transmission by asynchronous generator and synchronous motor. (Concluded.)

SHIPPING

German

German Shipping Hard Aground, H. Cole Estep. Mar. Rev., vol. 50, no. 6, June 1920, pp. 310-316, 12 figs. New construction, it is said, is virtually at standstill, plans are vague, and steel, coal and oil are all short.

SHIPS

Cargo

Steamship Eudunda Launched at Australian Naval Dockyard. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 550-552, 3 figs. Dimensions: Length, between perpendiculars, 331 ft.; breadth, molded, 47 ft. 9 in.; depth, molded to upper deck, 26 ft. 1 in.; deadweight capacity, 6000 tons.

Twin Screw Cargo Ship Eastern Merchant, C. Ano. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 547-550, 5 figs. partly on supp. plate. Freighter built by Asano Shipyard, Japan, for United States Shipping Board. Dimensions: Length overall, 461 ft. 7 in.; breadth, molded, 58 ft.; depth, molded to shelter deck, 40 ft. 1 in.; deadweight capacity, 13,000 tons.

50-Ft. Steamers, Trials

Trials of New Fifty-Foot Steamers Equipped with Turbine and Reduction Gear, William C. Owen. Jl. Am. Soc. Naval Engrs., vol. 32, no. 2, May 1920, pp. 311-325, 3 figs. Specifications of steamers: Length overall, 50 ft.; beam, 9 ft. 10¾ in.; weight, 44,700 lb.; draft to bottom of keel, 3 ft. 8 in.; fuel-oil capacity, 300 gal.

Loading and Unloading Refrigerated Cargoes

Inland Transport of Perishable Produce by Land and Water, A. R. T. Woods. Cold Storage & Ice Assn. Proc., vol. 15, 1918-1919, pp. 5-20 and (discussion), pp. 21-27, 19 figs. on 19 supp. plates. Proposed scheme of methods for discharging refrigerated cargoes from or loading them on ships, is included.

Rolling of

Experiments on the Rolling of Ships — I, Kyoji Suyehiro and Mishio Ishimoto. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 2, Nov. 25, 1919, pp. 39-51, 9 figs. partly on 6 supp. plates. It was determined that anti-rolling tank may be used advantageously only when period of tank is less than that of ship. It is accordingly concluded that period of tank must be made shorter than probable shortest period of ship.

Rolling of a Ship on a Non-Synchronous Wave (Les grands roulis sur houle non synchrone), Ch. Doyére. Bulletin Technique du Bureau Veritas, vol. 2, nos. 5 and 6, May and June 1920, pp. 89-93 and 116-119, 13 figs. Equations of motion. It is demonstrated that, contrary to accepted opinion, rolling on non-synchronous waves may be more dangerous to ship than rolling on synchronous waves.

[See also MOTORSHIPS.]

SHIPS, CONCRETE

Tests

The Strainagraph and Its Application to Concrete Ships, Franklin R. McMillan. Int. Mar. Eng., vol. 25, no. 7, July 1920, pp. 588-593, 14 figs. Records obtained of water pressure and resultant stresses in structure of vessel by use of pressure gages and strainagraphs.

SHOP COMMITTEES

American Development

Conclusions as to Shop Committee Plans, Charles Morris Mills. Iron Age, vol. 105, no. 21, May 20, 1920, pp. 1445-1447. Results obtained by shop committees in various manufacturing plants are quoted. It is concluded that on the whole shop committees, for the short period of their existence, have accomplished much.

SHOVELS

Electric

Operating Data on Large Electric Shovels at Queenstown Development, L. C. M'Lure. Eng. & Contracting, vol. 53, no. 20, May 19, 1920, p. 575, 2 figs. Chart showing energy consumption of electric shovel under actual working conditions.

SIGNALING

Acoustic

Code Calling Systems in Steel Plants, Vladimir Karapetoff. Iron Age, vol. 105, no. 22, May 27, 1920, pp. 1501-1503, 3 figs. Application, advantages, details of operation and electrical features.

SPRINGS

Helical

Practical Study of Helical Springs (Étude pratique des ressorts a boudin), A. Lamothe. Technique Moderne, vol. 12, no. 2, Feb. 1920, pp. 61-76, 8 figs. Formulæ, tables and graphs. Both round-bar and square-bar springs, are considered. A graphic method is indicated for solving systems of simultaneous equations including logarithmic equations of the form of those used for computing dimensions of helical springs.

STEAM

Air in, Effect on Heat Transmission

The Effect of Air in Steam on the Coefficient of Heat Transmission, C. S. Robinson. Jl. Indus. & Eng. Chem., vol. 12, no. 7, July 1920, pp. 644-646, 2 figs. Results of experiments at Massachusetts Institute of Technology. Empirical expression is formulated from results obtained.

Flow in Pipes

Charts for Graphical Determination of Pipe Sizes and Velocity of Flow of Steam, H. M. Brayton. Power, vol. 51, no. 19, May 11, 1920, pp. 762-763, 2 figs. Charts constructed from formula for quantity of steam which passes a given section of pipe in terms of diameter of pipe, and velocity of steam in pipe.

STEAM-ELECTRIC PLANTS

Design

High Wages Influence Power-Plant Design. Power, vol. 51, no. 23, June 8, 1920, pp. 917-919, 5 figs. Conversion of 3000-kw. station into one of 8000-kw. capacity.

Superstations, Economical Advantages of

Economies to be Expected of Superstation, John A. Stevens. Power, vol. 51, no. 22, June 1, 1920, pp. 879-884, 7 figs. Deals with economies to be expected of superstations, including heat balance, power costs at switchboard, latest form of by-product steam turbines for producing heating and manufacturing steam and economies that are obtained by using them, and suggestions regarding placing of super-power stations in large industrial communities.

STEAM ENGINES

Piston Valves

The Hochwald Piston Valve (Kammerschieber Bauart Hochwald). Der praktische Maschinen-Konstrukteur, vol. 53, no. 3, Jan. 22, 1920, pp. 21-23, 5 figs. Describes piston valve for steam engines operating alternately condensing and non-condensing, which in either case automatically regulates the final compression pressure and for different cut-offs, without any adjustment of valve or valve gear.

Steam Consumption, Determination of

Determination of Steam Consumption by Means of a Vaporimeter (Dampfverbrauchfeststellung mittels Vaporimeter). Kali, vol. 13, no. 22, Nov. 15, 1919, pp. 368-370. Description of an apparatus constructed and patented by Prof. Junkers, with which steam consumption of engines or turbines can be determined by measurement of the condensate, and which consists mainly of a surface condenser of a special design.

STEAM TURBINES

Blades, Efficiency of

Efficiency of Steam Turbine Blades (Considérations sur le rendement des aubages des turbines à vapeur), P. Nys. Annales de l'Association des Ingénieurs sortis des Écoles spéciales de Gand, vol. 8, only no. 1914-1918, pp. 1-46, 29 figs. Efficiency is computed for system composed of Curtis wheel and Rateau multicellular turbine.

Critical Speeds

The Theory of Critical Speeds (Zur Theorie der kritischen Drehzahlen), A. Stodola. Zeitschrift für das gesamte Turbinenwesen, vol. 17, nos. 1 and 2, Jan. 10 and 20, 1920, pp. 1-5 and 18-22, 9 figs. Supplementary notes to author's article on New Critical Speeds as a Result of the Gyroscopic Action of Rotors, published in same journal (1918, p. 253). Reference is made to work by Klein and Sommerfeld, describing gyroscopic action on the Delaval shaft, but only with regard to the steady precession, whereas in this article the counter-movement of this action is particularly discussed. Results of various experiments are given.

Extraction

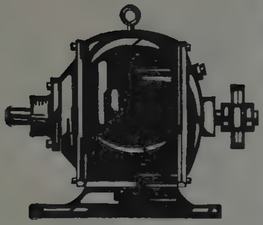
Steam Turbines for the Delivery of Low-Pressure Steam (Die Dampfturbine für die Abgabe von Niederdruckdampf), H. Baer. Zeitschrift für das gesamte Turbinenwesen, vol. 17, nos. 1, 2, 3, 4 and 5, Jan. 10, 20, 30, Feb. 10 and 20, 1920, pp. 5-8, 13-18, 25-29, 37-41 and 52-56, 32 figs. Description and schematic presentation of the two methods of delivering heating steam from a steam turbine, namely, removal of total amount of steam after part of its heat content has been transformed into mechanical energy in roters of turbine, or part of steam traversing turbine from an intermediate stage. Notes on thermodynamic relations; turbine and piston engines, with tabular data showing results of experiments on back-pressure and extraction turbines, etc., details and illustrations of various types of turbines of the German Gen. Elec. Co., the Zölly Syndicate, etc. (To be concluded.)

[See also MARINE STEAM TURBINES.]

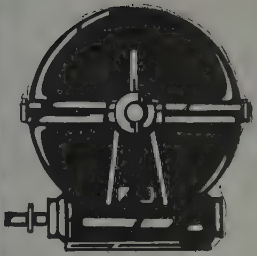
STEEL

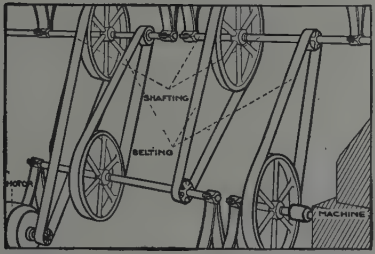
Analysis

On the Estimation of Carbide Carbon in Steel, Katsumi Inouye. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 6, March 30, 1920, pp. 145-154, 6 figs. partly on 2 supp. plates. Experimental. It was found that proportion of carbide carbon increases with rate of cooling, the more slowly the steel cooled below Ar_1 the greater being the amount. Thus it was determined that steel in sorbytic structure had 0.51 per cent carbide carbon, in pearlitic 0.71 per cent, and in spheroidized state 0.80 per cent approximately.

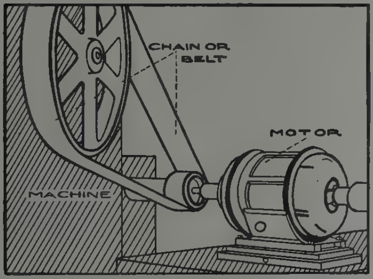


A battery of Foote Speed Transformers in use in the plant of the Republic Chemical Company, Pittsburgh, Pa.

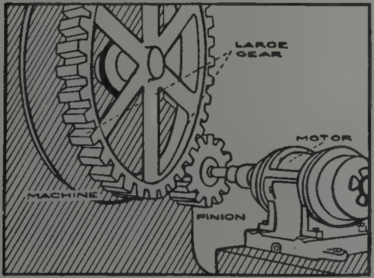




Where belts are employed, slippage results, causing power loss, frequent replacement and repairs and when used with shafting utilize valuable space.



The use of a large and small gear to provide speed reduction causes friction, excessive wear and power loss, often resulting in production delays.



The use of open reduction equipment is dangerous to workers and costly to employers. Dust, dirt and grit cause undue wear on belts, chains, sprockets and open gears. And it is impossible to obtain as great reductions as with Foote Speed Transformers.

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FOOTE SPEED TRANSFORMERS

ENGINEERING INDEX (Continued)

Hardening

Temperature Ranges in Hardening Steel, Carl T. Hewitt. Iron Age, vol. 106, no. 2, July 8, 1920, pp. 67-68, 2 figs. Relation of scleroscopic hardness and hardening temperatures in deg. fahr. are plotted from results obtained in forty tests. It is concluded that it is safe to harden tools of not less than 5-16-in. cross-section at temperatures as high as 100 deg. fahr. above Ac point without weakening steel.

Ingot Casting

Steel Ingots of Small Cross-Section, John G. Webb. Iron Age, vol. 105, no. 22, May 27, 1920, pp. 1497-1498, 6 figs. Method of casting ingots in groups from electric furnaces for direct rolling into horseshoes.

Ingots, Cooling of

Macrographic Study of the Propagation of Cooling in the Interior of a Steel Ingot from the Time of its Solidification (Sur l'étude macrographique de la propagation du refroidissement à l'interieur d'un lingot d'acier à partir de sa solidification), MM. Descolas and Prétet. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 18, May 3, 1920, pp. 1048-1051, 2 figs. Experiences are related in which writer succeeded in obtaining in ingots by treating them with solution of sulphuric acid lines formed of brilliant points. It is interpreted that these lines corresponded with isothermal surfaces during cooling.

Magnet, Testing

Notes on a Method of Testing Bars of Magnet Steel, N. W. McLachlan. Proc. Physical Soc. of Lond., vol. 32, part 3, April 15, 1920, pp. 154-165, 7 figs. Tests on cylindrical bars of magnet steel 1 in. in diamter and 10 in. long are described. Tests were conducted using slight modification of Ewing's double permeameter method. Instead of employing pinching screws in yokes bars and yokes were ground accurately to 0.001 in. and arranged to make a good push fit.

Specifications

Report of Committee A-1 on Steel. Twenty-Third Annual Meeting, Am. Soc. for Testing Matls., June 22-25, 1920, 42 pp. Phosphorus and sulphur requirements in A. S. T. M. steel specifications, and revised standard specifications for welded steel pipe, are included.

Sulphur Segregation by Aluminum

Aluminum Additions and Sulphur Segregation, Mark C. Smith. Iron Age, vol. 105, no. 21, May 20, 1920, pp. 1426-1427, 2 figs. Account of tests made to ascertain proper amount of aluminum requisite to prevent sulphur segregation. Carbon content of steel was 0.15 per cent. Ingot to which 10 oz. of aluminum per ton of steel were added showed best results.

Zirconium in, Determination of

The Determination of Zirconium in Steel, G. E. F. Lundell and H. B. Knowles. Jl. Indus & Eng. Chem., vol. 12, no. 6, June, 1920, pp. 562-567. Review of published methods for determination of zirconium in steels, and exposition of suggested method for determination of silicon, aluminum, titanium, and zirconium in steels containing other probable or possible alloying elements such as tungsten, chromium, vanadium, phosphorous, molybdenum, copper, nickel, cobalt, uranium, and cerium.

[See also ALLOY STEELS; IRON-CARBON ALLOYS; MANGANESE STEEL; MOLYBDENUM STEEL; NICKEL CHROME STEEL; PHOSPHORUS, Determination in Iron, Steel, etc.; STEEL, HIGH-SPEED.]

STEEL CASTINGS

Design and Treatment

Practical Notes on the Design and Treatment of Steel Castings, George F. Preston. Foundry Trade Jl. & Pattern-Maker, vol. 22, no. 222, June 1920, pp. 433-435, 9 figs. Prevention of piping, drawing and honeycombing.

STEEL, HEAT TREATMENT OF

Control

Relationship Between Dendritic Structure and Ferrite Mesh, Federico Giolitti. Chem. & Metallurgical Eng., vol. 22, no. 20, May 19, 1920, pp. 921-929, 42 figs. It was found in experimental researches in steel metallurgy that fir-tree crystals do not influence directly location of ferrite shells either in ingot structure or after drastic heat treatments, while physical properties of normalized castings depend primarily on an improvement of pearlitic kernels by gradual diffusion of segregates. From studies On the Control of the Preliminary Heat Treatment of Steel in Large Masses, published in Metallurgia Italiana, 1913.

High-Chromium Steel

The Heat-Treatment of a High-Chromium Steel, H. J. French. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July, 1920, pp. 103-109, 10 figs. Experimental determination of effect of various heat-treatments on tensile properties of steel containing about 11 to 15 per cent of chromium and from 0.20 to 0.40 per cent of carbon (stainless steel). With increasing quenching temperature hardness as measured by Brinell and Shore instruments increased until temperature of about 19.50 deg. fahr. was reached. Quenching from about 1750 deg. fahr. developed best combination of strength and ductility, which was not coincident with range of maximum hardness. Ductility as measured by elongation and reducon in area was very low in samples quenched from 1850 deg. fahr. or above.

Locomotive Forgings

Notes on the Heat Treatment of Locomotive Forgings and Similar Parts, Lawford H. Fry. Jl. Am. Steel Treaters Soc., vol. 2, no. 9, June 1920, pp. 435-441, 1 fig. Tables of quenching speeds and resulting physical properties.

Microscopic Study

The Microscope and the Heat Treatment of Steel, Albert Sauveur. Iron Age, vol. 105, no. 23 and 25 (Discussion), June 3 and 17, 1920, pp. 1586-1589, 10 figs. and 1717-1720, 8 figs. Photomicrographs illustrating various transformations in structure and properties under thermal conditions. Paper read before Am. Iron and Steel Inst.

The Use of the Microscope and the Heat Treatment of Steel, Albert Sauveur. Blast Furnace & Steel Plant, vol. 8, no. 6, June 1920, pp. 373-378, 10 figs. Also Am. Drop Forger, vol. 6, no. 6, June 1920, pp. 267-272, 10 figs. It is shown how microscopic study of steel has made possible improvements and refinements in heat-treatment of that metal which could not have been accomplished without its aid. Paper read before Am. Iron & Steel Inst.

Partial Cementation

Partial Cementation of Steel by Means of Solid Cements, Gordon A. Webb. Jl. Am. Steel Treaters Soc., vol. 2, no. 9, June 1920, pp. 442-450. Properties acquired by steels of different composition by carburization.

Plant

Heat Treatment for Continuous Operation, L. W. Heiser and J. L. M'Cloud. Am. Drop Forger, vol. 6, no. 6, June 1920, pp. 272-274, 2 figs. Proposed heat-treating plant, designed to treat 100,000 lb. of work, in which the operation is continuous.

STEEL, HIGH-SPEED

Tests

A Comparative Test Upon High-Speed Steels —III, A. J. Langhammer. Chem. & Metallurgical Eng., vol. 22, no. 20, May 19, 1920, pp. 939-942, 2 figs. Detailed description of method of procedure in testing 16 different commercial brands of high-steel tool steel, together with data as to performance of each individual tool, its chemical composition, heat treatment, and hardness.

STEEL INDUSTRY

Outlook

What the Outlook is for Iron and Steel, John A. Topping. Iron Age, vol. 105, no. 19, May 6, 1920, pp. 1307-1308. Supply is said not to have caught up with demand, but prices are not considered to be relatively high.

STEEL MANUFACTURE

Acid Open-Hearth Process

The Acid Open Hearth Process, B. E. L. De Maré. Iron Age, vol. 105, no. 23, June 3, 1920, pp. 1589-1593, 1 fig. Practice as carried out in open-hearth department of Nicetown Plant of Midvale Steel and Ordnance Co., Philadelphia. Paper read before Am. Iron and Steel Inst.

Bethlehem Steel Co.

Features of a Modern Steel Plant. Iron Age, vol. 105, no. 24, June 10, 1920, pp. 1657-1660. Steps in manufacture of steel products from raw material at Maryland plant of Bethlehem Steel Corporation.

Open-Hearth Process

Notes on the Acid Open Hearth Process, B. De Mare. Blast Furnace & Steel Plant, vol. 8, no. 6, June 1920, pp. 318-324 and p. 385, 3 figs. Discussion of practice as carried out in open hearth department of Nicetown plant of Midvale Steel & Ordnance Co.

[See also RAILS, Pineless ELECTRIC FURNACES, Induction; OPEN-HEARTH FURNACES, Gas-Fired.]

STEEL MILLS

Electric Repair-Shop Practice

Steel Mill Electric Repair Shop Practice, A. J. Standing. Jl. Engrs. Club of Phila., vol. 37-5, no. 186, May 1920, pp. 215-218. Practice of Bethlehem Steel Co., Bethlehem, Pa.

Electrically Driven

Electrically Driven Steel Reversing Mills, Fraser Jeffrey. Power, vol. 51, no. 26, June 29, 1920, pp. 1030-1033, 5 figs. Tonnage output per cost of operation and maintenance rather than first cost, it is said, is basis on which electricity is efficiently replacing steam as a mill drive. An installation is described in which a reversing motor and its necessary complements replaced an engine unit.

[See also SIGNALING, Acoustic.]

STOKERS

Tests

Mechanical Stoker Tests. Jl. Instn. Mech. Engrs., no. 4, May 1920, pp. 281-313 and (discussion) pp. 314-428. Details of performance of 80 typical mechanically fired "Lancashire" steam boiler plants in Great Britain. (Concluded.)

STREET CLEANING

Sweeping Costs

Forms for Motor Sweeper Cost Keeping, John Townshend Child. Public Works, vol. 38, no. 18, May 15, 1920, pp. 417-419, 2 figs. Methods and forms devised in Rochester, N. Y., for keeping cost records of street sweepers for aid in controlling work, making budget estimates, comparing and purchasing equipment, and determining special assessments.

STREET RAILWAYS

Car Materials

Railway Car Materials—Steel II, Norman Litchfield. Elec. Ry. Jl., vol. 55, no. 25, June 19, 1920, pp. 1247-1250, 3 figs. Discussion of physical and chemical properties necessary and their relation to strength and durability.

Improving Service

Merchandising Transportation, F. G. Buffe. Elec. Ry. Jl., vol. 55, no. 25, June 19, 1920, pp. 1251-1254. Various methods of disposing "of street car rights by merchandising methods" are discussed, including means for improving service, publicity of improvements and securing coöperation of trainmen.

SUBMARINE MINES

Depth Meter

A Recording Submarine Depth-Meter, Gilbert Cook. Eng., vol. 109, no. 2828, March 12, 1920, p. 333, 1 fig. Instrument designed to record depth of sweep wire throughout its length in mine-sweeping operations over shallow British mine fields.

SUBMARINE WARFARE

Model Experiments in Connection with Submarine Warfare, G. S. Baker. Shipbuilder, vol. 22, no. 117, May 1920, pp. 302-305, 1 fig. Notes on research work conducted in connection with devising nets to close up channels used by enemy submarines.

SUBMARINES

European Types

Submarines (Les sous-marins), A. M. Laubeuf. Revue de l'Ingénieur et Index Technique, vol. 26, no. 5, May 1920, pp. 491-521, 21 figs. Description of French, English and German types. (Continuation of serial.)

German

German Submarines, A. W. Johns. Shipbuilder, vol. 22, no. 117, May 1920, pp. 298-302, 7 figs. Information as to types, number, cost and other particulars.

SURVEYING

Rectangular-Coördinate

Rectangular Coördinates Used in Surveys and Maps, H. A. Foster. Eng. News-Rec., vol. 84, no. 20, May 13, 1920, pp. 962-963, 1 fig. Grid system based on Lambert projection, employed by armies in France, is recommended for civilian practice.

T

TAR

See WOOD, Tar Distillation.

TELEPHONY

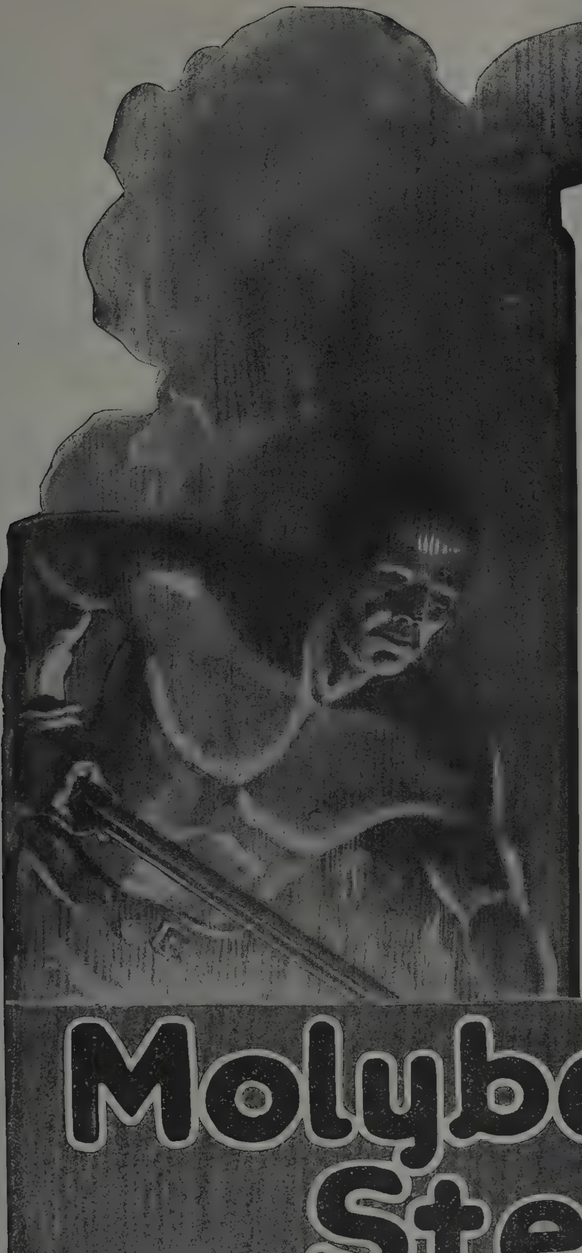
See PHOTOTELEPHONY; RADIOTELEPHONY.

TELLURIUM

See SELENIUM.

TEMPERATURE CONTROL

Automatic Control of High Temperatures. Iron Age, vol. 105, no. 22, May 27, 1920, pp. 1516-1517, 2 figs. Automatic recording controller manufactured by Leeds & Northrup Co., Philadelphia.



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ENGINEERING INDEX (Continued)

TERMINALS, MARINE

Freight Handling

Freight Handling at Marine Terminals, A. K. West. Int. Mar. Eng., vol. 25, no. 7, July, 1920, pp. 598-600, 4 figs. Methods at Boston Army Supply Base.

THERMOELECTRICITY

Joule Effect

Expansion Produced by Joule Effect of Contact between Two Solids (Sur la dilatation occasionnée par l'effect Joule au contact de deux solides), Jean Fallou. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 22, May 31, 1920, pp. 1308-1310. It was found experimentally that (1) when a contact of two metals is heated electrically, it expands proportionally to heat developed by Joule effect; (2) coefficient of expansion of contact increases directly with its resistances, and (3) there is no proportion between this coefficient and those of the metals forming junction.

TIDAL POWER

Utilization

Coupling of Electric Plants Utilizing Tidal Power (Couplage d'usines électriques utilisant la force des marées), Georges Mangin. Revue générale de l'Électricité, vol. 7, no. 19, May 8, 1920, pp. 626-631, 6 figs. If plants are built at two different points, so situated that high tide in the one corresponds to low tide in the other, and vice versa, coupling of these two plants, it is observed, will secure continuous supply of power. Construction and coupling of such plants at St. Malo and Brest is studied.

Utilization of Tidal Energy at the Mouth of Rivers (Utilisation de l'énergie de l'embouchure des fleuves), Ch. Andry-Bourgeois. Électricien, vol. 35, no. 1253, June 1, 1920, pp. 217-219, 1 fig. Scheme suggested consists in building canal at estuary of river. Turbines placed at middle of canal are operated continuously by flux and reflux of water.

TIMBER

Specifications

Report of Committee D-7, Annual Meeting Am. Soc. Testing Matls., June 22-25, 1920, 13 pp., 1 fig. Proposed revised tentative specifications for structural Douglas fir.

TIME

Measurement of

Representation and Measurement of Time (Représentation et mesure du temps), Edouard Guillaume. Archives des Sciences physiques et naturelles, vol. 2, Mar.-Apr. 1920, pp. 125-146. Kant's axiom, different times cannot be simultaneous, is applied to Lorentz' transformation. Investigation is carried in light of principles of theory of relativity.

TIME STUDY

Details of

Time and Job Analysis in Management—IV, William O. Lichtner. Indus. Management, vol. 60, no. 1, July 1920, pp. 28-34, 7 figs. Details and technique of taking time studies.

Training Men for

Establishing a Rate Setters' School in a Large Atlantic Coast Shipyard, George F. Barber. Indus. Management, vol. 60, no. 1, July, 1920, pp. 24-28, 1 fig. Methods used in selecting students, plan of subjects taught, practical work done and kind of examinations given, are described.

Unit Operations

Taking Up the Slack in Production, E. T. Spidy. Ry. Mech. Engr., vol. 94, no. 6, June 1920, pp. 392-394, 4 figs. How causes of lost time on unit operations are located and removed at Canadian Pacific Railway Angus shops.

TIN, SUBSTITUTE FOR

See ALLOYS, Cadmium-Arsenic.

TOOL-GRINDING MACHINES

Universal Automatic

New Automatic Universal Machine for Sharpening Tools for Lathes, Planers, Slotting Machines, etc. (Nouvelle machine automatique et universelle a affûter les outils de tours, raboteuses, mortaiseuses, etc.), Serge Héranger. Technique Moderne, vol. 12, no. 2, Feb. 1920, pp. 49-56, 12 figs. Machine carries several grinding wheels and accessory tool-supporting mechanisms which permit sharpening of any machine tool by inexperienced operator. It was used during the war in plant working for French Government, and was designed with a view to saving time lost by experienced workmen while sharpening their own tools.

TRACTORS

Wallis

New Tractor of Unit Construction Has Low Weight. Automotive Industries, vol. 42, no. 25, June 17, 1920, pp. 1397-1400, 5 figs. Wallis model K tractor. Weight is said to be kept well below average for machines of its rating by means of specially designed U-frame which serves as supporting member as well as housing.

[See also MOTOR TRUCKS, Engines.]

TRACTORS, FARM

Design

Analysis of Fundamental Factors Affecting Tractor Design, Oliver B. Zimmerman. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July 1920, pp. 7-12, 15 figs. Theoretical study of effects of slopes and weights on drawbar pull.

TRESTLES

Construction Plans

Construction Trestle Plans and Quantity Tables, F. J. Herlihy. Eng. News-Rec., vol. 84. no. 18, Apr. 29, 1920, pp. 844-847, 6 figs. Tabulations adapted to wide range of requirements intended to expedite work of estimator, purchasing agent and erection superintendent.

TUGS

War Service Tugs. Engr., vol. 129, no. 3343, Jan. 23, 1920, pp. 96-97, 10 figs. partly on supp. plate. High-speed model designed for going to rescue of torpedoed ships.

TUNNELING

Military, Belgian Coast

Tunneling in the Sand Dunes of the Belgian Coast, H. Tatham. Bul. of Instn. of Min. & Metallurgy, no. 188, May 1920, 12 pp., 8 figs. Work done by tunneling companies of British army.

TUNNELS

Arches in

Determination of the Load to be Supported by a Projected Subterranean Arch (Sur la détermination des efforts auxquels les voûtes des souterrains sont appelées à résister), M. Suquet. Annales des Ponts et Chaussées, vol. 54, no. 1, Jan.-Feb. 1920, pp. 96-103, 3 figs. General formula is developed and its application to special cases explained.

East River, New York

Pneumatic Caisson Tunnel Shafts. Public Works, vol. 48, no. 23, June 19, 1920, pp. 539-542, 5 figs. Steel concrete 34 × 62-ft. double shafts sunk 80 ft. for installation of eight shields for excavating tunnels under East River at 14th Street, New York. Walls built and sunk in successive operations. Roof of working chamber three times placed and removed.

Vehicular

Concrete Block Vehicular Tunnel Investigation. Public Works, vol. 48, no. 23, June 19, 1920, pp. 549-551. Wide roadway, concrete shell without cast iron and adoption of advanced practice effecting 50 per cent economy are favored.

[See also PUMPS, Air-Lift.]

TURBO-ALTERNATORS

Flux Distribution in Core

Flux Distribution in the Core of a Turbo Alternator, Carl J. Fechheimer. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 7, July 1920, pp. 669-673, 5 figs. Oscillograms are presented and interpreted.

V

VACUUM TUBES

Absorption of Gases

Absorption of Gases in the Electric Discharge Tube, F. H. Newman. Proc. Physical Soc. of Lond., vol. 32, part 3, April 15, 1920, pp. 190-195, 1 fig. Describes method of showing that absorption of nitrogen takes place in discharged tube when sodium and potassium are used as electrodes.

New Type

A New Discharge Tube That Permits the Emission of All the Rays Originating in the Tube into the Atmospheric Air (Ueber eine neue Entladungsröhre, die den Austritt aller in der Röhre entstehenden Strahlen in die atmosphärische Luft gestattet), W. E. Pauli. Physikalische Zeitschrift, vol. 21, no. 1, Jan. 1, 1920, pp. 11-14, 3 figs. Details of construction of a new type of discharge tube and its use for emission of Röntgen, cathode and canal rays.

Plate Current

Some Notes on Vacuum Tubes, John M. Morecroft. Proc. Inst. Radio Engrs., vol. 8, no. 3, June 1920, pp. 230-260, 22 figs. Value of exponent connecting plate current and plate grid potentials is experimentally investigated for a number of tubes. It is found to be markedly different for different tubes, and for the same tube at different plate voltages. Capacity and conductance within tubes are also experimentally determined for several tubes.

Pliotron

An Electron-Tube Transmitter of Completely Modulated Waves, Lewis M. Hull. Jl. Washington Acad. Sciences, vol. 10, no. 11, June 4, 1920, pp. 316-323, 2 figs. Type "P" pliotron.

[See also IONIC VALVES.]

Saturated, Specific Heat of

The Specific Heat of Saturated Vapour and the Entropy-Temperature Diagrams of Certain Fluids, J. A. Ewing. Lond., Edinburgh & Dublin Philosophical Mag. & Jl. of Sci., vol. 39, no. 234, June 1920, pp. 633-646, 6 figs. Diagrams constructed for alcohol, benzine and ether.

VAPORS

Pressure-Temperature Relations

Pressure and Temperature Relations for Vapor of Liquids, P. B. Williamson. Chem. & Metallurgical Eng., vol. 22, no. 25, June 23, 1920, pp. 1151-1156, 1 fig. Derivation of formulæ and vapor pressure-temperature alignment chart.

VISCOSITY

Chart

Chart of Viscosities in Different Systems, H. G. Nevitt. Chem. & Metallurgical Eng., vol. 22, no. 25, June 23, 1920, p. 1171, 1 fig. Chart is arranged to give corresponding viscosities in four systems, Saybolt Universal, Redwood, Engler and Absolute.

VOLTAGES

High Static

An Apparatus for the Production of High Static Voltages, J. J. Dowling. Sci. Proc. Roy. Dublin Soc., vol. 15, no. 48, Jan. 1920, pp. 673-676, 1 fig. Principle of operation is "condensing electroscope" of Volta, operated in a continuous manner by mechanical means.

VOLTMETERS

Amplifying Direct-Reading

Direct-Reading Amplifying Voltmeter (Voltmétre amplificateur a lecture direct), MM. Abraham, E. Block and L. Block. Bulletin de la société française des Électriciens, vol. 10, no. 85, Jan. 1920, pp. 9-24, 4 figs. Alternating current is first amplified and subsequently rectified by detector valve. It then passes through milliamperemeter which gives voltage reading in specially constructed scale.

W

WALLS

Brick, Economical Construction of

Economical Brick Construction in Spite of High Costs and Shortage of Building Material (Wirtschaftliche Ziegelbauweise trotz Teuerung und Baustoffnot), H. Natho. Tonindustrie-Zeitung, vol. 44, no. 21, Feb. 17, 1920, pp. 189-191, 6 figs. Brick hollow wall called Tauber wall after inventor, which is made up of ordinary bricks with application of a simple, practical bond, and elimination of iron, wood, concrete or other costly building materials.

WASTE HEAT

Utilization of

Waste Heat and Its Importance in the Conservation of Heat (Die Abwärme und ihre Bedeutung in der kommenden Wärmewirtschaft), E. Reutlinger. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 42, nos. 51 and 52, Dec. 19 and 26, 1919, pp. 394-397 and 401-404. Writer sets forth that waste heat from engines and furnaces should be used in place of fresh steam for heating and that installations should be changed for this purpose. Excess heat should be stored and delivered by long-distance lines in form of hot water or steam to other consumers.

WASTES

Municipal, Disposal of

Disposal of Municipal Wastes, Joseph Goder. Public Works, vol. 48, no. 19, May 22, 1920, pp. 444-446. Writer discusses several methods of disposal, giving his reasons for concluding that incineration is decidedly preferable for some classes of waste in all cases and for all classes in some cases. Interrelation of collection and local characteristics of several classes of waste material with most desirable method of disposal is pointed out.

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ENGINEERING INDEX (Continued)

WATER

Turbidity Standard

Turbidity Standard of Water Analysis, P. V. Wells. Sci. Papers, Bur. of Standards, no. 367, March 17, 1920, pp. 693-721, 4 figs. It is claimed that present standard of turbidity of water analysis is inaccurate, variations from average mounting in some cases to over 50 per cent. It is pointed out that this could be eliminated largely by having all these standards prepared by Bur. of Standards, without changing the specifications at all. If the standards were thus centrally prepared, it is noted, it would not be necessary to use platinum-wire for regulating size of particles.

WATER FILTRATION

Bacterial Removal, Efficiency in

The Operation of an American or Rapid Water Filtration Plant for Twenty Years at York, Pa., James M. Caird. Jl. Am. Water Works Assn., vol. 7, no. 3, May 1920, pp. 368-376. Attention is called to data which show that filtrates removed 98.7 per cent of bacteria.

Detroit Plant

Detroit's New 350-Million Gallon Filtration Plant, Theodore A. Leisen. Eng. News-Rec., vol. 84, no. 25, June 17, 1920, pp. 1194-1196, 2 figs. Old open reservoir to be covered for filtered water. Short mixing chamber. Steel roof over coagulation basin.

Drifting-Sand Filters

Sandwashers for the Drifting-Sand Rapid Water Filter, William Gore. Eng. News-Rec., vol. 84, no. 25, June 17, 1920, pp. 1192-1194, 2 figs. Loss-of-head studies at Toronto plant.

Mechanical

Investigations on the Presence of Alumina Hydrate in Mechanically Filtered Water, Norman J. Howard and Frank Hannan. Contract Rec., vol. 34, no. 20, May 19, 1920, pp. 454-455. Work was done at Toronto filtration plant laboratories. Occurrence of aluminum hydrate was noticed in all waters examined. Its presence in Toronto water, however, is believed to be devoid of any sanitary significance.

WATER HAMMER

Conduits Under Pressure

Water Hammer in Metallic Conduits Under Pressure (L'étude des coups de bélier dans les canalisations métalliques sous pression), C. Camichel. Houille Blanche, vol. 19, no. 39-40, March-April 1920, pp. 53-57, 14 figs. Amplitude of odd harmonics. (Continuation of serial.)

WATER MAINS

Cleaning

Water Main Cleaning in St. Louis, Mo., Edward E. Wall. Mun. & County Eng., vol. 58, no. 6, June 1920, pp. 249-252, 2 figs. Mechanical cleaner used for street water mains.

[See also OXY-ACETYLENE WELDING, Pipe Mains.]

WATER PIPES

Leaks

Leaky Cross-Connection Located by Alkali Test, W. Mack Angus and Carl Francis. Eng. News-Rec., vol. 84, no. 25, June 17, 1920, pp. 1187-1188. Method used in locating cross-connection betwen dual supplies.

WATER POWER

Legislation

Synopsis of New Water-Power Law, Henry J. Pierce. Elec. World, vol. 75, no. 26, June 26, 1920, pp. 1467-1472. Text of measure is included with brief statement of purport and main provisions of law.

Operating Costs of

Water Power and Conservation, H. deB. Parsons. Mun. & County Eng., vol. 58. no. 6, June 1920, pp. 244-248, 1 fig. Chart showing hydroelectric average operating cost per kw.-hr.

WATER SOFTENING

Hot Process

Development of Hot Process Water Softener, George Gibson. Blast Furnace & Steel Plant, vol. 8, no. 6, June 1920, pp. 325-326, 3 figs. Sorge-Cochrane softener.

WATER SUPPLY

Booster Station

Combined Gas and Motor-Driven Pressure Booster Station, A. E. Walden. Power, vol. 51, no. 24, June 15, 1920, pp. 950-952, 5 figs. Details of two pressure booster stations, consisting of combination gas-engine and motor-driven centrifugal pump units of 75 and 150-hp. capacity, each with pumping capacity of 2,000,000 gal. of water daily, at 55 ft. to 115 ft. and 231 ft. head respectively.

Montreal

The Municipal Water Supply of Montreal, T. W. Lesage. Can. Engr., vol. 38, no. 26, June 24, 1920, pp. 584-587, 1 fig. Water is sterilized by hypochlorite. Average daily consumption for 1919 was 65,046,000 imp. gal. Paper read before American Water Works Association.

WATER TREATMENT

Clay and Silica Removal

The Removal of Clay and Silica From Water, Otto M. Smith. Jl. Am. Water Works Assn., vol. 7, no. 3, May 1920, pp. 302-314, 10 figs. List of electrolytes is given arranged in the order of their efficiencies as coagulants, and results of tests with these electrolytes are presented in diagrammatic forms.

Rainfall and High Bacterial Count

An Inquiry Into the Effect of Metorological Conditions Upon the Efficiency of Storage, Filtration and Chlorination, Based Upon a Study of the Hagerstown Water Supply, Abel Wolman. Jl. Am. Water Works Assn., vol. 7, no. 3, May 1920, pp. 352-363. Fundamental cause producing excessive bacteria counts in tap water was found to be excessive rainfall.

WATER WORKS

Centrifugal Pumps in

The Use of Centrifugal Pumps in Municipal Water Plants, Russell A. Murdoch. Mun. & County Eng., vol. 58, no. 6, June 1920, pp. 253-255 and p. 258, 3 figs. Performance curve of centrifugal pump operating against constant head.

Construction

Cost-Plus Contracts for Water Works Construction, George W. Fuller. Can. Engr., vol. 38, no. 26, June 24, 1920, pp. 599-601. Comparative advantages and disadvantages of cost-plus and lump-sum contracts.

Electrically Driven

The Application of Electric Motive Power to Small Waterworks Plants in Indiana, D. D. Ewing, and G. C. Blalock. Purdue University, Publications of Eng. Departments, vol. 3, no. 3, Dec. 1919, 100 p. 47 figs. Survey of plants. Electrically driven pumps, it is said, have proven highly satisfactory. It is added; that no troubles were found which were directly chargeable to mode of operation. It is also mentioned that first cost of an electrically operated pumping plant is from 25 to 50 per cent of that of a steam pumping plant. Bibliography on electrification of pumping stations is appended.

WATER WHEELS

Current Wheel, Feathering-Paddle

Floating Hydraulic Wheel with Feathering Paddles (Rueda flotante de paletas móviles), F. A. Soldano. Contribución al Estudio de las Ciencias físicas y matematicas, Universidad nacional de la Plata, vol. 1, no. 7, Nov. 1918, pp. 499-509, 7 figs. Hydraulic wheel installed at Coronda, Argentina, for raising river water a height of 40 ft. for irrigation. Water is operated by kinetic energy of current of river. Paddles are composed of two folding panels which open gradually as they enter the water, receiving complete impact of current when fully submerged.

WATTMETERS

Reactive Volt-Ampere Measurements

Reactive Volt-Ampere Indicators, H. C. Yeaton. Elec. World, vol. 75, no. 26, June 26, 1920, pp. 1476-1479, 10 figs. It is shown how standard indicating wattmeters may be applied to measurement of reactive volt-amperes by selecting suitable scales and making proper connections in circuit.

WAVES

Force of, Estimating

On a Method of Estimating the Force of Waves, I. Hiroi. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 1, June 30, 1919, pp. 1-19, 9 figs. partly on supp. plate. It is concluded from study of empirical formulae and results of experiments that greatest intensity of wave pressure is found near water surface, acting on comparatively small area. It is believed that mean intensity of pressure on large area is hardly capable of direct measurement, and use of reliable formula is considered as only practical method for estimating probable mean wave pressure in any given locality.

Power from

An Experimental Determination and Utilization of Wave Power, I. Hiroi. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 1, June 30, 1919, pp. 21-36, 6 figs. partly on supp. plate. Describes apparatus for measuring wave power consisting of float board weighted with stones making large pendulum, which is allowed to swing freely under stroke of waves. Amplitude of motion of pendulum measured at each stroke gives amount of available energy. Apparatus is also described for compressing air in container by exposing grated opening of large pipe to alternate action of wave. Check valve between container and pipe permits accumulations of compressed air in container.

WELDING

Automobile Repair Work

Welding and Its Relation to the Repair Industry, Lord Campbell, Jr. Jl. Soc. Automotive Engrs., vol. 7, no. 1, July, 1920, pp. 42-46, 4 figs. Welding is classified into four general headings: Forging, oxy-acetylene or other gas processes, electric arc and thermit methods. Field of each one of these is pointed out with special reference to automobile repair work.

[See also ELECTRIC WELDING; OXY-ACETYLENE WELDING.]

WELFARE WORK

Store Departments

Advantage of a Company Store to a Plant, E. E. Adams. Am. Drop Forger, vol. 6, no. 6, June 1920, pp. 288-290. Experience of forge-plant superintendent who conducted company store in connection with supply department, in which, it is said, he saved his workmen 20 per cent. Paper read before Am. Drop. Forge Assn.

WIND TUNNELS

Design

The Design of Wind Tunnels and Wind Tunnel Propellers, Edward P. Warner, F. H. Norton and C. M. Hebbert. Nat. Advisory Committee for Aeronautics, report no. 73, 1919, 24 pp. 16 figs. Application of Dryewiecki theory.

WIRE ROPE

Care of

Suggestions for Care of Wire Rope, James F. Howe. Eng. World, vol. 17, no. 1, July, 1920, pp. 36-37. Directions for attaching sockets to wire rope are included.

WOOD

Tar Distillation

Tar-Still Operation in Hardwood Distillation Plants, L. F. Hawley and H. N. Calderwood, Jr. Jl. Indus. & Eng. Chem., vol. 12, no. 7, July, 1920, pp. 684-685. Tests made to determine effects of speed and steam pressure. Directions for tar-still operation are suggested.

[See also AIRCRAFT CONSTRUCTION MATERIALS, Wood.]

WOODWORKING MACHINES

Molder

A Semi-Automatic Molding Machine for Wood (Halbautomatische Holafräsemaschine). Holzwelt, vol. 7, no. 11, Feb. 6, 1920, pp. 5-6, 4 figs. Machine for production of profiled articles of wood or similar material.

Surface Polisher

Wooden-Surface Polishing Machine (Poliermaschine für Holzflächen). Holzwelt, vol. 7, no. 6, Jan. 20, 1920, pp. 6-7, 1 fig. Machine differs from the general type in having in place of one polishing head several which are concentrically arranged around a shaft, and operated by means of a planet gear.

Y

YACHTS

Oil Electric

The Oil-Electric Yacht "Guinivere." Am. Marine Engr., vol. 15, no. 4, April 1920, pp. 9-10. Power plant is to consist of two 6-cyl., 350-hp. model 24-A Winton Diesel oil engines of 225 r.p.m., each direct-connected to a 225 kw., 125-volt Westinghouse d.c. generator.

Z

ZINC METALLURGY

Muffles

Pressure in Zinc Muffles (Ueber die in den Zinkmuffeln herrschende Spannung), O. Mühlhaeuser. Metall u. Erz, vol. 16, no. 22, Nov. 1919, pp. 538-544, 7 figs. Results of experiments are said to show that pressures existing in combustion chambers within a period of distillation do not vary considerably, whereas pressures in muffles constantly increase or decrease, or greatly fluctuate; pressures within muffles are for most part greater than in zinc ovens, sometimes less or approximately the same, and same is true of tensions in condensers which are just as great or less than pressures in the muffles.

Mechanical Engineering

Including The Engineering Index

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C. 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

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Contributors and Contributions

Fundamentals of Appraisal and Valuation in Engineering Practice

J. R. Bibbins

The series of appraisal papers in this number was presented at the last Annual Meeting of The American Society of Mechanical Engineers and further discussed at the last Spring Meeting, at St. Louis. These papers were arranged for by a committee consisting of Dean M. E. Cooley, Past-President, and J. R. Bibbins, the author of the first paper, and give progressively the historical basis for the economic conditions affecting appraisals, a discussion of conditions met with preliminary to actual completion of a project, and a brief survey of valuation practice. In introducing his paper at the Annual Meeting, Mr. Bibbins called attention to the seriousness of the present situation brought about by the lamentable failure of engineers to agree upon a codification of their definitions, methods, and practices in valuation procedure, especially when ultimate decisions must finally rest upon the shoulders of courts, commissions, or non-technical bodies. A policy of open-minded coöperation, research, and education along fundamental lines of economics is urged, rather than a continuance of purely partisan methods of thought and action.

Experiments on Ozonating Water

An extensive series of experiments lasting over a period of years was carried out by A. E. Walden of the Baltimore County (Md.) Water and Electric Co. to perfect the design of apparatus for ozonating the water supply of communities. The readers of this Journal are fortunate in having a summary of the results of this important work in an article in the present number by Mr. Walden.

Data on Electric Welding from Bureau of Standards and Westinghouse Company

Two contributions to the records on Arc Welding are included in the current issue through the able offices of the Washington Section of the A.S.M.E. During 1918, at the request of and with the coöperation of the Welding Research Sub-Committee of the Emergency Fleet Corporation, an extensive program was outlined by the Bureau of Standards for the Study of Electric Arc Welding of Steel. The first paper, by Henry S. Rawdon of the Bureau of Standards, a presentation of a portion of the Bureau's results, treats of the properties of the arc-fused metal, upon which the efficiency of the weld is dependent. In the second paper, O. H. Eschholz of the Westinghouse Electric and Manufacturing Co. describes the basic phenomena occurring, as well as the weld properties obtained when employing the metallic electrode process.

Depth of Copper Plating Necessary to Prevent Carburization of Steel

An investigation was conducted by F. P. Zimmerli at the University of Michigan to determine the necessary depth of copper plating when employed as a non-carbonizing material on steel. While copper plating is largely used for this purpose, apparently but little information has been published on the least amount of copper which must be used to prevent the penetration of carbon into the steel within a specified time. In carrying out his experiments, the author found that his results agreed very closely with those given in the paper on case carburizing, by Marcus T. Lothrop, presented before the A.S.M.E. in 1912, but obtained by an entirely different method.

For the Professionally Spirited Engineer

The Correspondence Department in the current issue is worthy of careful perusal. The greatest American development in engineering organization, The Federated American Engineering Societies, is the topic of discussion by Charles Whiting Baker and Howard Coffin. Neither of these men require introduction to the engineering reader.

The increased standing of the engineering profession in this day of advanced civilization brings a discussion of a Code of Ethics to the foreground of interest. Professor Christie is chairman of the committee that drafted the A.S.M.E. Code. To render a code satisfactory to all engineering points of view is no mean labor, and Professor Christie's request for careful consideration is entitled to attention from every engineering reader.

American Engineering Council of F. A. E. S. to Hold First Meeting

Further information upon The Federated American Engineering Societies is given on page 596, with the program of the first meeting of its governing body, to be held in Washington, November 18 and 19. Several additional societies have joined the Federation, which has already become a strong and going organization.

James Hartness Nominated for Governor of Vermont

The latest prominent example of the entry into public affairs by engineers is the recent nomination of James Hartness, Past-President of the A.S.M.E., as Republican candidate for Governor of Vermont. The story of his campaign, which was entirely unique, is told in this number.

A.S.M.E.
ANNUAL MEETING
December 7-10, 1920

The 1920 A.S.M.E. meeting will feature the presentation and discussion of the transportation problem. Six Professional Sections will hold sessions. A session on Woodworking and a number of important general papers are assured.

For complete information on
A.S.M.E. Affairs
See Section Two of
MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

Volume 42 October 1920 Number 10

Appraisal and Valuation of Properties

Rational Valuation; Price Levels in Relation to Valuation; Cost of Organizing and Financing Public Utilities; Interest and Taxes During Construction; as Discussed at St. Louis Meeting of A.S.M.E.

In response to frequent requests from engineers for a discussion of the appraisal and valuation of property, sessions for this purpose have been held at the last two general meetings of The American Society of Mechanical Engineers. In arranging for these, a special effort has been made to contribute results of definite value in the broad field of appraisal and valuation. By such discussions as these it is hoped to bring about practical coöperation among members of the engineering profession, so that new light and more effective guidance may be given to the courts and commissions who in the end are obliged to rely upon technical findings in reaching equitable judgments.

At the two sessions mentioned, five papers were presented, of which one, Methods of Appraisal and Valuation, by David H. Ray, has already appeared in Mechanical Engineering.[1] Abstracts of the other papers appear below. These papers are as follows: Rational Valuation, J. R. Bibbins; Price Levels in Relation to Valuation, Cecil Elmes; Cost of Organizing and Financing a Public Utility Property, F. B. H. Paine; Methods of Computing Interest and Taxes During Construction, H. C. Anderson.

The purpose of the first paper is to emphasize the breadth of view which a complete valuation should hold in order to be of the greatest usefulness, especially with reference to the facts of history. The author makes a comparative study of valuation practice illustrated by a complete economic analysis of a large utility from the period of the Civil War to the present time, yielding in substance the history of the five-cent trolley fare.

Similarly, the second paper is a study of commodity prices. The author traces the changes that have taken place in prices and wages in this country and England since very early times. He believes that greatly reduced commodity prices are not to be expected unless lower wages are to be taken for granted. He further points out that the laws of economics as outlined in the paper must apply to public utilities as well as to other things, and that in any proceeding the word "dollar" should not be used to mean two different amounts, a high figure to one party and a low figure to the other in one and the same controversy.

The third paper discusses the preliminary steps which must be taken before a project is finally launched. These embrace the development of the project and the securing of sufficient capital funds for preliminary outlays and for the actual construction of the utility.

Finally, the fourth paper takes up the proper allowances to be made for interest and taxes during the period of construction—items frequently ignored in the early days of appraisals and for which latterly excessive figures have often been used.

At the first session at which the papers were presented, the time was given almost entirely to the reading of the papers. In Mechanical Engineering for July 1920, there is a summary of the discussion of the papers which took place at the second session held at St. Louis last May.

Rational Valuation—A Comparative Study

By JAMES ROWLAND BIBBINS,[2] CHICAGO, ILL.

Valuation should be characterized as cold fact and engineering judgment combined. We should at least agree on facts. To clear the decks, let us eliminate what may be regarded today as the established mechanics of the valuation method. All of the factors noted below are probably admissible as facts, although the specific rates of construction overhead (items 7-10) may be subject to discussion and variance according to the kind of property, the locality and the historical period during which it was built. Then follow the principal contestable factors.

Admissible Facts

1 Extent of property owned and establishment of unencumbered title
2 Physical inventory in detail or by type of percentage-method according to accuracy desired. (Engineering approximations favored)
3 Cost extension based on original voucher costs or representative normal average costs. (Current costs as of date used in special cases)
4 Age of original structures still in use and property superseded
5 Normal life and rate of renewal encountered in shorter-lived property under peculiarly local conditions, such as ties, investment in an established property?
6 Initial expenses, legal and otherwise, incident to organization and construction
7 Engineering and superintendence prior to and during construction—i.e., cost of construction organization.
8 Specific carrying charges, such as interest, taxes, insurance during construction
9 Discounts on construction finds not covered by normal interest rates
10 Accrued depreciation existing as a physical fact, not considering, for the moment, its application.

Contestable Factors

1 Purpose of the valuation as affecting "value":
  (a) Taxation (b) Accounting (c) Condemnation
  (d) Rate-making (e) Purchase or Transfer
  (f) Capitalization, and recently, during high prices
  (g) Insurance
2 Original Cost vs. Cost-to-Reproduce New theory under
  (a) Original conditions of construction, or
  (b) Conditions today with modern substitute plant
3 "Original Conditions" logically associated with actual Cash Costs (actual investment). Likewise current prices today with substitute plant where obsolete elements are considered
4 Appreciation in values since original construction, principally in real estate and earning value, recently in all material and labor.
5 Accrued depreciation on physical elements due to age, wear, inefficiency, and being out of date (obsolescence)
6 Franchise value, early losses, going concern, cost of developing the business, good-will, etc., asset or liability, or neither?
7 When does a business drop from a "going concern" to a "losing venture" and necessarily subject to lower return?
8 The range of applicability of current or "spot" prices: (a) Boom prices; (b) Panic prices. Has a spot value (as of today) any weight in an absolute determination of capital investment in an established property?
9 Should the true cost of service include at all times as an element of operating expenses, the wearing down or depletion due to accrued depreciation?

Scope of a Complete Valuation

From the above it will be apparent that to attempt intelligent discussion of "Value" involves sidetracks and pitfalls in hopeless number, unless the issue is most clearly defined and limited. For it is a fact that, by reason of contractual requirements, public necessity, and the rights of society of past, present, and future generations, not to mention the investors, business with its risks and its responsibilities has reached an exceedingly complex stage. So that it no longer suffices to value a great property as a boy's jack-knife, "unsight—unseen." The writer submits instead that a proper valuation must view the subject from all possible angles, such as:

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[1] December, 1919, p. 931.

[2] Supervising Engineer, The Arnold Co., Mem. Am. Soc. M. E.

a The actual true plant investment cost as built, from historical studies

b The cost to reproduce plant as it exists today under reasonably normal prices—i.e., neither boom nor panic prices, which is a check on (*a*)

c The cost to develop the physical property to its present state of efficiency; called Plant Development Expenses

d The money loaned for commercial development, called Deferred Earnings during development

e The present shrinkage in physical plant from aging or other form of depreciation

f The contractual and moral responsibilities of the owners to the public and vice versa

g The history of development, net income for fixed charges and true adjusted return on net plant investment.

In other words, valuation especially for rate-making purposes has risen from simple arithmetic to the high level of an economic science requiring the utmost power of analysis, accounting judgment and vision. It demands the facts from the past, the conditions of the present and the outlook for the future.

Upon this substantial foundation may then be built up the case in question. In fact, a rate case rests upon a so-called three-legged stool, the economic stability of which rests in turn upon (1) Basic Value Assigned, (2) Rate of Return allowed on that value, (3) Disbursement of Income. To shorten any leg overturns the stool.

Time was, with the phrase "Public Utility" yet unborn, when properties were conceived, built, and operated distinctly for personal or corporate profit, without restriction, just like the industries furnishing the equipment. The major difference between utility and industry rested upon that intangible asset (or liability) called a franchise. Thus came to be established the personal point of contact with the public; in railways the most intimate, in telephones less so, and in light, power, and gas the least. And right here, unconsciously, industry became the public's business, as time and bitter experience have proved.

But here was the rub; when the utility industry awoke to the true cost of service based upon proper cost accounting, the balance sheet footed red. With income practically fixed, costs rising, depreciation mounting and right to do business expiring in the face of new conditions imposed by a more intelligent public, a readjustment became inevitable.

Meanwhile, private industry boomed, under no restraint as to right to do business and enjoying flexible rates to absorb variations in cost of service, with no limit except that imposed by competition. Hence earning power became the principal basis of capitalization as it has been to an unfortunate extent in the early acquisition of utilities. The difference was that, while perhaps justified in industry, it was not justified in the case of utilities, owing to the specific incumbrance of the franchise.

The economist, John H. Gray, has shown[1] that Federal regulation was devised to limit risk by preventing speculation and thereby to stabilize values accordingly—i.e., a police power which has already been exercised in the cases of utilities, banks and insurance companies, but only now taking form in the case of the private industries. Also he has demonstrated that the real difference between public and private property is that one is subject to the "servitude" or incumbrance of specific public service, the other is not, and that this incumbrance entirely vitiates franchise value, which itself is dependent upon rates fixed by public authority. Here we run around in a complete economic circle.

Is any one wise enough to deny the possibility of ultimate Federal regulation over industry such as that of the Interstate Commerce Commission over common carriers, and that such control will be based on the following principles:

a Actual investment cost contributed by the owners

b Rates calculated upon this investment

c Variable risk, requiring varying charge rather than variable value.

In other words, to stabilize values by eliminating the speculative element more and more, in essential industries.

It appears to the writer that fundamentally utilities and industries are not dissimilar as to the various aspects of valuation relating to the physical properties; and that only the speculative element is shrouded in doubt, which at least is minimized in the utilities subject to public regulation and protection.

The Value of Economic Research

At the very foundation of rate making lies the determination of the true Cost of Service, or of product. It is no exaggeration to say that much of the controversy over valuations could have been avoided entirely had it been possible for the contending parties to view the complete facts concerning which there could be little or no argument.

Concerning the valuation basis, it is a matter of common knowledge that the partisan viewpoint has performed wondrous acrobatics in shifting from actual investment to replacement cost, then back to original cost, and again to cost to reproduce new on current prices. In earlier usage, "cost to reproduce new" was generally held to mean cost to reproduce in brand-new condition the property inventoried, under construction conditions and prices prevailing. Later, the definition was broadened somewhat in general usage so as to mean "cost to reproduce new," under substantially "original" conditions, the property inventoried, using normal prices or prices averaged over a term of years where wide fluctuations occurred. Quite recently, the scope of valuation has undergone still further modifications in the effort to satisfy the condition where the owners are held entitled to receive "a fair and reasonable return on the actual investment," which requires the determination of the historical value, i.e., the total actual cash investment resulting from efficient administration in (1) producing the property, (2) operating it efficiently, (3) extending it as required and (4) maintaining it at the physical standards necessary for reasonable requirements of the service. This later interpretation of "cost to reproduce" obviously attempts to reproduce the original cost and in fact, were no historical records available, such a value would probably represent closely the original cost of a property built in times of normal conditions and prices.[1]

Looking, then, into the future of valuation methods, can we escape the necessity of visualizing original cost at least as the starting point of valuation, in any direction of enterprise, and with the facts available as revealed by economic research, will there not be far less to squabble about?

Opening the Door of the Past

In order to crystallize the principal thoughts presented in this paper, a typical case may be used for purposes of illustration.[2] The exhibits represent a comprehensive study of all phases of development of a typical railway property from its inception, keeping an open mind as to what constitutes fair value for rate-making purposes today and taking into consideration essential economic elements of past, present and future. This is a deliberate attempt to illuminate the complex problem confronting society as a whole in fairly distributing the burden of development and operation of its public utilities. The study presents what may be termed the problem of three generations and illustrates, it is hoped, in unmistakable terms, the practical difference between renewals (or completed depreciation), accrued depreciation (or unmatured renewals), and amortization (a purely actuarial process designed to liquidate a debt). Further, the study shows the essential need of a definite amortization policy under all franchises of finite term and especially under short-term franchises. And here is the cause, usually neglected, of most of the contention over the admissibility of depreciation; i.e., whether the principal of the funded debt can be paid back, at expiration of franchise, either directly or by previous amortization.

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[1] Trans. Am. Soc. M. E., 1916, p. 1247.

[1] The single exception is the appreciation of realty values by time and development. Some deny the right to appreciation over actual cost. However, it seems clear that land is a somewhat different classification from other physical property. And there is also involved an exceptional factor —viz., that the public, by taxation, recognizes value at least to the extent of the taxables reported; it could not justly deny value and tax it too.

[2] Presented by courtesy of Bion J. Arnold, Consulting Engineer, Chicago.

History of the Five-Cent Fare—Fig. 1

Net Investment, the upper curve, shows the progress and growth of a typical property and should be held in mind as an approximate measure of the relative size of the property and volume of operations for the early and late periods of development. This represents the actual property in operation as would be determined by inventory at any year, at the original cost, i.e., all superseded and abandoned property is deducted. It will be noted that the horse-car operations are relatively unimportant, as the horse property was only about one-fourth the size of the electric property today, and would probably average not more than one-fifth.

Annual Rate Earned curve indicates the annual net income balance (applicable to fixed charges, amortization, and surplus) in per cent of the average net investment for the year. In computing this return, the superseded and abandoned property is charged off in the year superseded. As a matter of fact, practically no amortization reserves have been built up in this property to absorb accrued depreciation by reason of the evident insufficiency of income of past years. The annual rate earned is then more apparent than real.

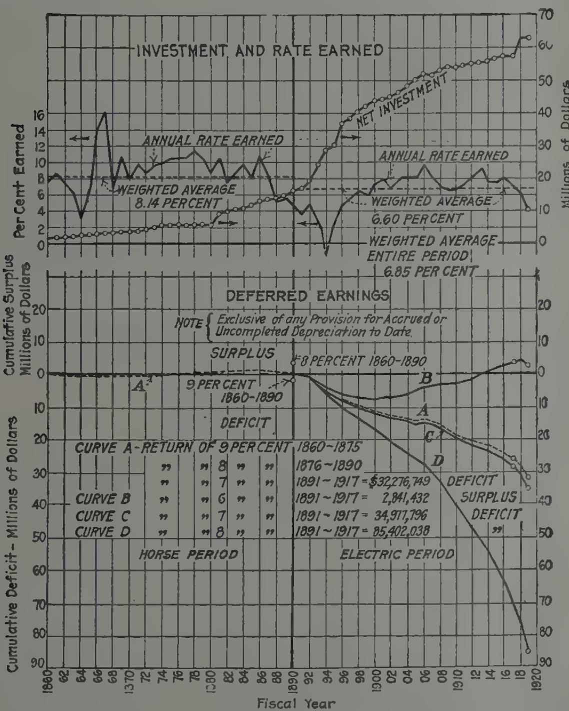

Fig. 1 Historical Investment and Deferred Earnings

Deferred Earnings, curve *D,* shows the cumulative surplus and deficit in this net income balance, or, in other words, the relative possibility of the electric lines as a whole earning an assumed fixed rate of 8 per cent on the net investment for fixed charges, amortization, and surplus. Consequently, the downward tendency of curve *D,* after electrification was completed, really indicates the true trend of electric-railway operations in comparison with the income realized from the rates of fare actually established and in force. These deficits were compounded at this rate as they had to be funded; likewise the surpluses. Curve *C* corresponds to a rate of 7 per cent and Curve *B* to 6 per cent, for the electric property. Curve *A* covers the entire history horse and electric operation corresponding to a rate of 7 per cent electric period and 8 to 9 per cent during the horse period, the rate of the early years recognizing the higher cost of money commensurate with the risk involved.

The zero line of Fig. 1 obviously represents par; i.e., for a continuing, stable business there should be no cumulative surplus or deficit at a rate of return, taken over a long period, adequate for the support of this investment. Now the hard facts which the owners of these properties face today as drawn from this typical economic study may be summarized as follows:

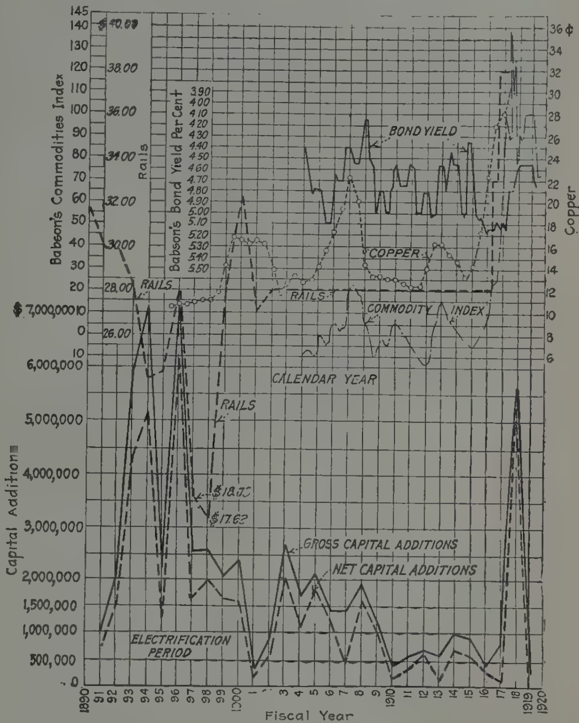

Fig. 2 Relation of Construction Work to the Market

Apparent Rate Earned, 1860-1890	6.85 per cent
Apparent Rate Earned, Electric Period, 1891 to 1919	6.60 per cent
Actual Rate Earned, Electric Period, corrected for actual deficits and crediting surpluses	6.10 per cent
Actual Rate Earned, Electric Period, further corrected for assumed amortization of Accrued Depreciation to date	5.27 per cent
Actual Rate Earned, Electric Period, finally corrected to cover Renewal Fund payments necessary to meet future Renewal Liability (basis, pre-war normal prices) . .	5.03 per cent

All rates expressed as weighted averages.

Thus the actual economic history of electric operation in this property is seen to be on a true basis of about 5 per cent, which would necessitate in financing 4 per cent bonds and 6 per cent stock, assuming the same amount of each issued on the property. Obviously, enormous discounts could not very well be avoided on such a basis.

Relation of Construction Work to the Market—Fig. 2

The lower curves trace the rate of capital investment per year in the electric property (and the extensive supersession) as compared with the upper curves of market price levels. Evidently the major construction and reconstruction work was not carried out during periods of excessively high prices, which has an important bearing upon the study in substantiating the Original Cost appraisal basis. (The apparent exception for 1918 capital additions is explained by the fact that the abrupt increase for the year is due to taking over property formerly rented.)

ADJUSTMENT CURVE OF DEFERRED EARNINGS—FIG. 3

This curve is designed to interpolate rates and earnings between the curves *B*, *C*, and *D* of Fig. 1, so that one may find an expression for the particular rate which he considers "fair" for such a property. The curve measures the deferred earnings of the electric period resulting from the assumption of any given apparent rate earned. Thus, this property averaged 6.60 per cent, but without any provision for funding deficits or meeting Accrued Depreciation. The curve shows that to carry these deficits an annuity of 0.50 per cent was required, reducing the actual rate earned at part to 6.10 per cent (amortization would further lower it 0.83 per cent and renewal liability 0.24 per cent, or to 5.03 per cent final return). It will now be apparent that the financial policy of a utility as compared with an industry may be extremely handicapped by the deficiency in income resulting from a too rigid bargain for franchise and fares.

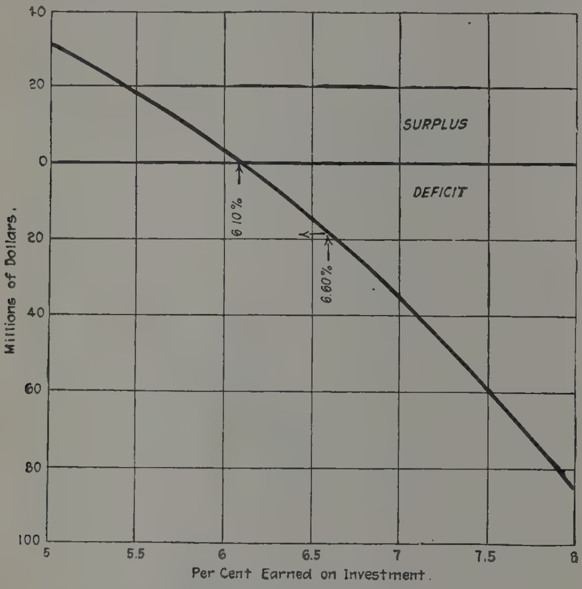

FIG. 3 ADJUSTMENT CURVE OF DEFERRED EARNINGS

ESTIMATED FUTURE RENEWAL LIABILITY—FIG. 4

How many properties make a serious attempt to ascertain with any degree of accuracy their future renewal maturities, such as illustrated in Fig. 4? At the left, the actual costs of past maintenance and renewals are shown, rising to a maximum, equivalent to 20 per cent of the gross earnings. Then came the retrenchment of war years, and the actual physical renewals were even less than the money renewals because of the higher cost. Here is a renewal program based on original cost and reflecting exactly the depreciation schedules of the appraisal except that maturities were spread so as to lessen the severity of the peaks.

The principal result shown is that the future requires about $1,300,000 per year to maintain the integrity of the property. Obviously, the only sensible way to meet this condition is by a renewal fund just sufficient to carry the property over the maximum peak of the future. To amass such a fund by the year indicated, 1923-24, would have required an annuity of 0.24 per cent during the entire electric period. This explains the term used, renewal liability.

THE THIRD GENERATION, PAY-AS-YOU-GO, OR PAY-DOWN—FIG. 5

We now come to the crux of the entire problem under discussion, a problem as broad as that of society and social justice. In view of the rapid advancement of the art and the impossibility of foreseeing the ultimate result of rigid franchises granted long years ago, what financial plans with respect to rate making can be devised which will hold the maximum of justice and fairness to investor and public and distribute most equitably the cost of service and cost of development without economic shock? Three typical plans will illustrate.

Plan *A* assumes a "fair deal" as to franchise expiration—i.e., either a continuing or indeterminate franchise requiring necessarily no amortization of either funded debt nor depreciation; in other words, the "pay-as-you-go plan," renewing the property only as fast as the maturities indicated by Fig. 4. Here each generation takes care of itself; pays for renewing plant actually worn out by its predecessors, and passes on to the future its own burdens. In a normally expanding and renewed property, however, this plan is the simplest and cheapest.

Plan *B* assumes a definite expiration of franchise and actual liquidation of the business. Obviously there is no other alternative than an amortization fund to validate the principal of the investment when the property is taken over by the city at "actual present value" (and there is little reason to believe that this will be any other than Original Cost New less Accrued Depreciation, despite present-day contentions for boom prices). Here, then, the rate must include an amortization charge depending upon the contractual term of the franchise. This plan holds practically the only fair economic solution if Public Policy has set definitely towards Depreciated Value as a basis of rates.

Plan *C* interprets the result of a determination to adopt depreciated value at once as a rate basis. This means that 20 to 30 per cent of the investment must be liquidated, provided sufficient returns have not been earned in the past over and above fair return to absorb this shrinkage. But Fig. 1 has shown this not to be the case. There is then no other reasonable alternative but to transfer the amortization charge to the future as in Plan *B*, basing rates on a gradually reducing capital value resulting from the progressive amortization. As a result the public would be supporting, in 1942, an investment no greater than in 1898, although the actual property would be 50 per cent larger.

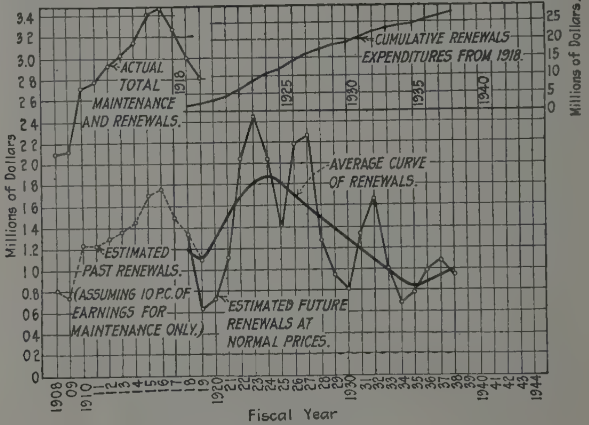

FIG. 4 ESTIMATE FUTURE RENEWAL LIABILITY

Assume that depreciated value is today in fact imposed by courts and commissions. Then the following alternatives hold in this particular property:

- *a* The past generation has accepted service at less than cost and the franchise bargain was a bad one and the shrinkage a dead loss, or
- *b* The present and future might accept a double amortization charge sufficient to refund at some future date (which is unthinkable) both the shrinkage and deferred return thereon.

But the concluding fallacy is exposed also in Plan *C*, for in this property an inventory each year between 1923 and 1938 would show an actual depreciated value in excess of the assumed agreed value today (neglecting for simplicity capital additions). The conclusion is plain—that depreciated value as a rate basis must be reappraised annually, or determined currently by a perpetual inventory and inspection (depreciated by the usual methods); otherwise, confiscation plainly enters into the controversy, as shown graphically by Fig. 5. Obviously such a method of current valuation would result in the maximum expense and complexity. If we had made sensible bargains in the past, with sufficient rates for a "pay-down plan," depreciated value might be acceptable in principle. That is, if past riders had actually paid for the property *they* wore out, in full; but this was rarely the case.

The economic conclusions from the study are either (1) that the electric railway has been a losing venture, and therefore should be scaled down to a new par securities basis, or else (2) that the public's responsibility has been unintelligent in permitting malnutrition while accepting service below cost. The responsibility is certainly mutual although rarely considered so, except by the aggrieved party.

Facing the Facts

Is it not clear from the foregoing that the vagaries and inconsistencies of appraisal procedure could have been largely avoided thus:

1 By closer study of past history
2 Economic research into all fundamental facts
3 Reasonable forecast of future income and liabilities
4 More complete appraisal reports dealing with every aspect of reasonable value
5 An open mind—not trying to find the answer before we start
6 Acceptance of accrued depreciation as a physical fact to be handled like any other actuarial problem
7 Cost to reproduce theory used judiciously to reflect the original cost as nearly as possible
8 Institution of perpetual inventories and values based upon well-maintained and preserved records
9 Development of flexible or sliding scale methods as basis for rates, service and return on investment
10 Adopting for utilities the practice of progressive industry in preserving its physical and economic integrity. Pay down "while the paying is good"
11 An attempt to educate rather than to obstruct or defeat Public Policy.

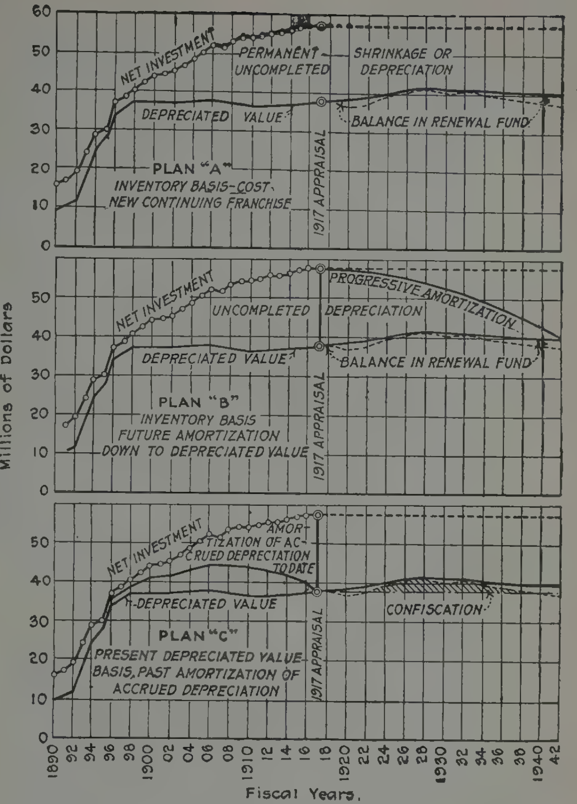

Fig. 5 Financial Plans for Rate-Making Purposes

Price Levels in Relation to Value

By CECIL F. ELMES,[1] CHICAGO, ILL.

In most rate controversies and appraisals, the opposing engineers are commonly able to agree within very reasonable limits on all purely engineering features. It is when these are set aside and economic questions are broached that sweeping differencs appear. Engineers labor faithfully to reach an agreement within twenty thousand dollars on the "bare bones" value of a street railway, or of an electric utility, and then proceed to differ by perhaps two million dollars as to the overhead costs which should be applied to this figure. Their disagreement is not upon engineering but upon economic features, and the results to the public utility business as a whole are so serious that I have no apology to make for devoting myself in what follows to the subject of economics.

Let us start with a precise definition of two of the words in the title of this paper—"Value" and "Price." John Stuart Mill defines the value of a thing as "its general power of purchasing, the command which its possession gives over purchasable commodities in general."

Particular attention is called to the word "general" in this definition. All discussion of value by the great economists is predicated upon the assumption of a free exchange of commodities, with freedom of communication and transport and willing buyers and sellers. The inquiry is never as to the peculiar value of a particular article, such as an heirloom or the last morsel of food among the survivors of a shipwreck. The broad conception of value as set forth by Mill is no more intended for such individual application than an actuary's tables of mortality are intended for use in forecasting the date of a particular individual's death.

The New Standard Dictionary defines "Price" as "The amount demanded by an owner in return for an article as the condition of sale . . . the quantity of labor which its possessor will take in exchange for it."

What relation, in practice, the price demanded by the owner will bear to the value as defined by John Stuart Mill depends upon the circumstances of the case. The likelihood of the two being identical increases, generally speaking, with the available supply of the article, and the readiness with which it may be obtained from any one of a number of sources. The commonness of an article makes it difficult or useless to set an exorbitant price upon it.

In determining the value of any piece of property which is the subject of litigation, courts have always been swayed, and quite properly so, by consideration of the price which the article would fetch if placed upon sale, then and there, under conditions fair to both a willing seller and a willing buyer.

Why Prices Fluctuate

Price, as defined above, can be arrived at in terms of money or of labor. In the economic civilization of today we always quote prices in money. If we possessed an ideal currency not liable to fluctuation in its intrinsic worth, prices of commodities would vary in accordance with the laws of supply and demand, the demand for any commodity tending to cause a rise in its price, and conversely a lack of demand leading to the commodity being offered at a lower price. However, the currency of this and every other country is manufactured out of metals which are themselves commodities subject to the laws of supply and demand and to consequent variations in market price.

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[1] Sanderson & Porter.

Another variable element which must be considered in dealing with fluctuations in market price is foreign exchange, or the ratio at which the currency of one country is traded for the currency of another.

Low Prices

The idea is quite prevalent that we will all be more prosperous when the present high prices give way to lower levels. The fallacy of this hope lies in the fact that lower prices usually result from a lack of demand for commodities, and a lack of demand means a slowing up in commerce, a depression in business, and its result—a lack of employment for labor. Let any one who is clamoring for low prices refer back to such a time as the early 90's of the last century, when commodity prices were at their lowest. The financial panic of 1893 was an effect of prolonged hard times rather than a cause and the charts shown hereafter make it clear that a profound industrial depression overspread the country.

High Prices—Panic or Famine Prices

If low prices, then, are no blessing, high prices in the same way are by no means a curse. In general, they indicate prosperity, of which the times we live in afford abundant proof. In spite of all clamor against high prices, not only are commodities of every kind being eagerly bought, but it is the judgment of retail merchants that the most expensive wares command the readiest market. At no time within the recollection of the present generation have luxuries been more sought, or has their distribution been more widespread.

So long as the free exchange of commodities goes on, high prices are, generally speaking, an indication of prosperity. It is only when the free exchange of commodities comes to a breakdown point that this ceases to be true. The definitions and conceptions of economics are based upon a free exchange of commodities, and they must not be projected into an analysis of the conditions which result when the exchange ceases to be free, or when the ordinary processes of commerce collapse. In such a case we have panic or famine prices. The most common occasions of panic or famine prices are crop failures, the monopolistic act of an individual merchant or group of merchants, or the warlike act of a belligerent in cutting off supplies.

Wages

One of the vital commodities whose price must be considered in any general discussion of price fluctuation is labor. In what follows, labor will frequently be dealt with in terms of the commodities which may be purchased with it. No serious student, however, can afford to treat labor solely as a commodity and wages solely from the standpoint of a price for that commodity.

It is useless to talk about selling a particular article at a price which will not allow a living wage to the workers producing it. As intelligent and progressive citizens, we are forced to postulate a decent living wage in every industry and to regard any commodity price incompatible with this requirement as basically unsound.

Statistics compiled upon the wages of bricklayers in the state of New York, machinists in the state of Pennsylvania, and laborers in the state of Illinois during the last sixty or seventy years, show the first have multiplied by more than four; the second by five; and the third by nearly seven. This relates only to the monetary increase without reference, for the moment, to how much the increased wages will buy.

In view of the fact that labor enters so largely into the cost of every commodity, we have in the foregoing a reason to anticipate a higher level of commodity prices today as compared with the commodity prices of sixty or seventy years ago. The increased efficiency and productiveness of the wage earner will act, of course, as an offset to this. Nevertheless, anyone urging lower commodity prices should first take thought as to how far he is committing himself to a demand for lower wages. And anyone who demands that property be valued today on the basis of what it would have cost to produce it in some bygone year should be ready to squarely meet the issue of whether he is not thereby committed to championing the wages current at that time.

Commodity Price Indexes

In studying the upward or downward movement of commodity prices as a whole, economists have evolved various systems of commodity price index numbers. An index number, applied to commodity prices, is evolved by any one of several methods of averaging actual market prices of the important articles of commerce. A list of basic commodities is selected which the economist regards as being of sufficiently wide range and commercial importance to fairly reflect the commerce of the day. At regular intervals, say every month, an index number is arrived at which is to represent the combined fluctuations of the commodity market. Sometimes the index number is obtained by simply averaging the unit market prices of all the commodities on the selected list. Sometimes the prices of the individual commodities are weighted to correspond with their relative importance as to: (*a*) quantity consumed; (*b*) vital significance to the life of the community.

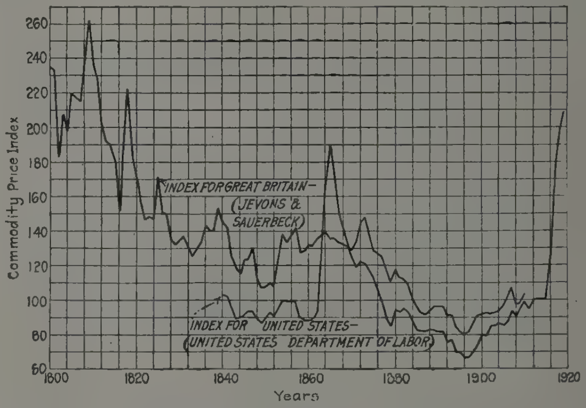

Fig. 1 Index Numbers of Wholesale Commodity Prices in the United States and Great Britain in the Nineteenth and Twentieth Centuries

There is vastly more iron sold, for instance, than indigo. It would be a criticism against an index number of fluctuations in the indigo market modified it as profoundly as changes in the cost of so basic a commodity as iron. Weight for weight there might be as much paving brick sold as wheat, yet there is no comparison in its importance to human life. An index number which is as largely affected by a change of the market price of paving brick as of wheat is open to criticism. Each commodity price index is therefore largely dependent upon the judgment of the statistician who evolves it and in this way quite a number of commodity price indexes have become current.

Perhaps the most authoritative index in the United States is that published by the Bureau of Labor Statistics of the United States Department of Labor, which will be frequently referred to here. The Bureau has published an index number going back as far as 1860, and in the data compiled for the Aldrich investigation the same index number was carried back as far as 1840. Over 320 commodities are now considered in compiling this index number. Other important index numbers for the United States are those compiled by *Dun's Review* and by Bradstreet; Gibson's index and that of the *Annalist* are also widely used. In England, the London *Economist's* index and that of Sauerbeck are, perhaps, two of the most important. French commodity prices may be studied from the index number of the *Statistique Générale.*

In Fig. 1 the degree of resemblance will be observed between the index number of the Department of Labor from 1840 to 1919 and the Sauerbeck index for England, the latter being carried back to 1800 by means of tables compiled by W. S. Jevons, the distinguished economist. In this diagram the present practice of the Department of Labor has been followed of using the average commodity price index number for the year 1913 as "100."

The Department's practice in this respect is convenient, inasmuch as it enables us to use the current index numbers as published month by month by the Department to show directly the change in current purchasing power of the dollar as compared with prices prevailing shortly before the war. For instance, the last published number is 226 for the month of August, 1919. That is to say, commodities which could have been purchased for $1.00 during the year 1913 would have cost in August last $2.26.

Analyzing Past Prices and Wages

If we desire to arrive at intelligent conclusions regarding the probable future movements of prices, a careful analysis of past price movements is well worth our while, but at the outset it is necessary to utter a word of caution. Amateur statisticians often attempt to predict the future by literally projecting forward such curves as those in the charts accompanying this paper. Nothing is easier than to take a pencil and ruler and project some of these curves forward into the future. Nothing is more meaningless, or, generally speaking, more misleading. Facts of great value can be obtained from a study of past prices but not by such juvenile proceedings.

The real value of such charts is for the purpose of determining the *underlying causes* of the price changes which occurred in the past. Only when we do this and note their effect can we speculate intelligently on the possible future of commodity markets. There are three groups into which we may divide the factors most profoundly affecting commodity prices:

1 First, the events of contemporary history, wars, revolutions, pestilences and famines. Any study of commodity prices for the last seventy years in the United States which failed to take an account of the Civil War would be a waste of time.

2 Second, the commercial and industrial development of the individual commodities. Any study of brick buildings in England which disregarded the fact that there was a prohibitive tax on brick down to quite a modern period could scarcely have any value.

3 Third, those social and economic movements which have profoundly influenced the welfare of man, without necessarily involving war or revolution. A study of the increase in cost of erecting a brick building which failed to disclose that the wages of bricklayers have in some places multiplied by eight in the last seventy years could not possibly be complete.

[Following this the author takes up these three factors in turn, showing how each in its way has influenced commodity prices. In studying commodity prices in the light of contemporary history, he shows a chart of price indexes in England from the year 1600 to the year 1918 in which are recorded fluctuations due to the great economic and social upheavals occurring during this long period. (Fig. 2.) In relation to the second factor of commercial and industrial development, a study was made of the cost of iron during the 500 years since its discovery, an epoch which the author divides into 12 periods, in each of which there have been economic or industrial conditions which have had a marked influence on the prices of iron.

Finally, in dealing with the third factor, that of economic movements which have influenced the welfare of men, he prepared a chart, reproduced in Fig. 2, in which are plotted the wages of English workmen in certain trades during the 300-year period considered in connection with Fig. 1, in his study of the fluctuation of commodity prices. The chart in Fig. 2 expresses the wages both in dollars per day and in terms of the commodities which might be purchased therewith. "It appears to indicate," the author states, "(*a*) a prolonged period from 1600 on for almost a century, during which the purchasing power of wages was lower than it has ever been since; (*b*) a noteworthy improvement setting in toward the end of the seventeenth century and culminating in the period 1730-1740; (*c*) another long period of depression in the second half of the eighteenth century and extending beyond 1810, practically to the time of the fall of Napoleon; (*d*) a great and continuous upward trend in the buying power of wages culminating about 1900."

Turning to history for an explanation of the causes of the fluctuation of the purchasing power of wages in these several periods, the author attributes the low purchasing power in the first to the state of abject poverty existing in England at that time—a period when it is estimated there were paupers and beggars to the number of 1,333,000, or more than one in five of the population. Following this came the adoption of sound currency and an improvement in conditions until the third period, that of the Seven Years' War, and the development under the German kings of England of a tyrannous government which led to the Revolution. During that period the factory system was in full swing with an oppressive system and unhealthy conditions prevailing, a day's work consisting of 15 or 16 hours and young children regularly working in the mills 14 hours a day. The fourth and last period covers the improvement of the status of the workingman which is one of the great features of the nineteenth century.]

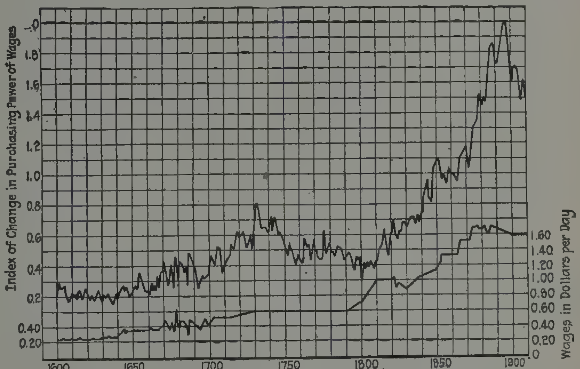

Fig. 2 Wages of an English Artisan (Carpenter or Mason) from the Year 1600 to the Year 1918

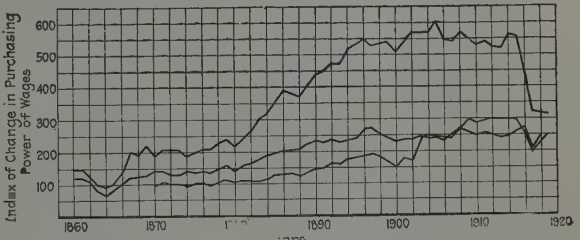

Fig. 3 Relative Change in the Purchasing Power of Wages of Certain Classes of Wage Earners in the United States from the Year 1860 to the Year 1920

American Wages in the Light of Commodity Prices

Turning to modern American wages, compared with the corresponding commodity prices, as plotted in Fig. 3, conditions are in striking contrast to the grim picture presented in former times in the history of English labor. The unit or index employed to measure the relative change in the purchasing power of a workingman's day's labor is not important. It is the rate of change in this index which is significant, the fluctuation in the purchasing power of his day's work from year to year. If that is ascending, it is fair to assume that his conditions are improved. If it shows a steady decline, it is reasonable to suspect that his conditions are becoming worse. The reader must be cautioned in regard to peak or high points. While apparently indicating prosperity to the individual artisan in continuous employment, they take no account of the fact that the bulk of unemployment may be great and actual distress is the result.

No claim is made that the curves in Fig. 3 are in any way complete for the purpose of such a study of the labor situation. That is not the primary purpose of this paper. Nevertheless, even with the small amount of data here presented, it will be noted how the workingman's conditions have improved, even allowing for the fact that the curves in Fig. 3 do not show to the full many recent wage increases. Taking Fig. 3 as it stands, however, labor today appears to have increased its purchasing power over conditions in, say, 1870 in a ratio of roughly fifteen to thirty. That is, the purchasing power of a man's working day yields approximately twice as much in commodities as it did in 1870. The standard of living of the workingman has greatly improved. This is a highly desirable condition. Without a doubt this country as a whole has greatly benefited from raising the living standard of the wage earning portion of the population. Further, no one will claim today that a lack of demand for labor is to be reckoned as nullifying the improvement in buying power of the wages an artisan receives.

Predicting the Future Course of Prices

I have emphasized the fact that any efforts to predict future prices by projecting forward from a curve or graph of former prices by means of a ruler are foolish. Nevertheless, the inquiry as to what may be anticipated in the future will always be raised, and we are thoroughly entitled to use our best judgment in hazarding a prediction.

A guess as to the future price of an individual commodity must necessarily allow for progress and invention in that particular industry. A guess as to the future movements of commerce as a whole must be based upon some reasonable assumptions as to the general direction of human and economic progress. Great historical events, such as wars and revolutions, may be expected to produce big effects in the future, as in the past, but we are practically unable to predict them at all, and therefore cannot make allowance for them in future prices. Setting such greater disturbances aside, we may still do something towards forecasting future prices in the light of events of today.

The predominant element in making up the price of any commodity today is labor. Therefore, if any man claims that prices are to come down, without at the same time predicting great advances in the way of invention to increase the efficiency of labor, he is really arguing that the price of labor also is coming down. Any prophets who forecast lower commodity prices in the near future (particularly some of those whose prophecies are used as a basis for making rates on public utilities) should be forced to admit that they are in effect taking future lower wages for granted and when they do this they must be made to recognize that the burden of proof of any such claim is upon themselves.

Relation of Commodity Prices to Public Utilities

At first sight it might seem unnecessary to call attention to the relation of public utilities to the prevailing commodity prices of today. It ought to be self-evident. The public-utility man is just as much a merchant as any other merchant. How can he fail to be affected by conditions that affect every living human being? And yet, the events of the past two or three years, in fact events of the last decade, show that this apparently self-evident fact is not evident at all to a large section of the public. An immense number of people seem to be educated to the idea that the butcher, baker, and candlestick maker are all living with them in the year 1919, but public utilities, in some mysterious way, are expected to live half in the present and half in the pre-war past. A dollar bill handed to them for the payment of a 1919 electric-light bill is to be able to transact as much business for them, to purchase as much raw materials and labor as it could have done in, say, the year 1913—although it is fully recognized that it has no such occult power in the hands of the customer who tenders it to them.

I will hazard a guess that future generations may look back with curiosity to some of the practices now in use in valuing railroad property throughout the country. As fast as a railroad completes construction today, with labor and materials purchased and erected today, paid for at the prices of today, the rate-making body proceeds to place a "valuation" upon the newly completed construction work based not on what it actually cost, not on what any living human being could do it for today, but on the assumption that a magician built the work with labor and materials called up out of the past at the prices current on June 30, 1914. Whatever legitimate use a "valuation" of the railroads of the country "as of June 30, 1914" may be thought to have, it would surely seem that this order of "theorizing" a value constitutes nothing less than a perversion of economic thought.

Setting a Price on the Service of a Public Utility

Assuming then, the prices we find actually prevailing in the market today, how shall we set a price upon the service of a public utility? Exactly as we determine the price of any other merchandise. What shall we pay for it? We should pay for it what the service is worth. How shall the worth be measured? In terms of the currency used to pay for it. If the service was worth $100 in 1913, and if $226 in August, 1919, will buy as much of commodities in general as $100 bought in 1913, then public utility service (or any other service) that was worth $100 in 1913 is, *ceteris paribus*, worth $226 today.

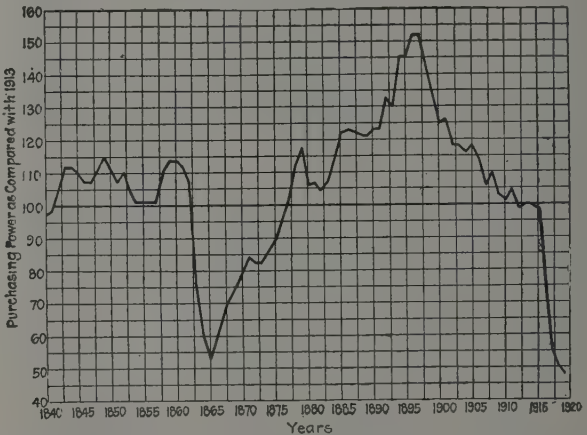

Fig. 4 Fluctuation in Wholesale Commodity Purchasing Power of the Dollar from the Year 1840 to the Year 1919

Any one conversant with the way in which public utility rates are determined today will know that no such thought is ever entertained. On the contrary, elaborate property valuations are prepared, based sometimes on what the property would have cost if built at some other and more remote period, sometimes based upon no price that ever was. Prices are often used in valuation of public utilities, as many of you know, based on a trend curve, whose author takes the position that while the prices of a certain date were, in fact, what every one knows them to have been, they really ought to have been something else. The record of rate cases in the last two years is full of instances where nobody in the entire proceeding discussed anything in terms of the market prices then actually prevailing and being paid by every individual present at the rate hearing for every commodity necessary to keep himself alive.

How Rate Proceedings Should Be Influenced by Current Commodity Prices

Am I, then, to be understood as suggesting that all pre-war valuations be abandoned and only valuations as of the present day be employed? I have been asked this question frequently in the last six months, and the answer to it is that I am not much interested what basis is used for valuing a company's property and for setting up the facts relating thereto so long as both the company and its customers get equal treatment. But if a rate-making body is to carry on its work using the word "dollar" in the same rate case to mean two different things, to mean a dollar of high purchasing power every time one party to the controversy is mentioned, and a dollar of low purchasing power every time the opposing party is mentioned, then there is an elemental injustice present in the proceeding. Can it be claimed as fair that a dollar should have the purchasing power of 1913 ascribed to it whenever a public-utility company's property is being evaluated in dollars, while all parties are fully aware that rates can only be paid in the dollar of today with its vastly different purchasing power?

The investor in a public utility is already severely enough injured by the change in purchasing power of the dollar. To a vast extent his investment has been made out of savings effected in times when the dollar was the fruit of far more labor and material than it is today. One thousand dollars invested in the public-utility business ten years ago represents a much greater amount of labor and a much greater amount of thrift than a corresponding thousand dollars invested today. More of a man's life and toil went into it.

The United States Department of Labor commodity price index, as shown in Fig. 1, puts the figures of the situation in their fair relation. The labor and frugality which will produce 226 dollars today produced only 100 dollars six or seven years ago. We may not be able to remedy this situation; it may be inherent in our economic and financial system, and may be part of the burden that the investor must bear. But there certainly is no use in denying it or covering it up, and certainly none in talking as if the burden and hardship did not exist.

In Fig. 4, in which I have expressed the United States Department of Labor's commodity price index in terms of the shrinking purchasing power of the dollar, I have followed the Department's lead in using the index for 1913 as a base point, calling it 100 cents on the dollar. It will be noted that the purchasing power of each of the six or seven or eight dollars which the investor of 1913 looked to as the income to be derived from each hundred of his savings has shrunk today until each dollar can accomplish only what 44 cents accomplished at the time he made his investment. The chart shows how severely he has been hit.

The Cost of Organizing and Financing a Public-Utility Project

BY F. B. H. PAINE[1]

INTRODUCTION

HAVING been associated with the late Mr. Paine on important work, and being familiar with his views based on his investigations into somewhat unusual phases of public-utility valuation, it has occurred to me that wider publicity should be given his views than has resulted from his expression of them in reports and before utility commissions. The following paper by him was prepared in July, 1916. It was in fact a report on a particular property. In order to adapt it to the requirements in the present instance I have made a few changes—those which make it read for the general rather than a particular case. No changes in substance have been made. Mr. Paine was an unusual man. His wide experience along the lines of his paper particularly qualified him to express the views set forth. In discussion of them he was most forceful and convincing. It affords me great pleasure to render this service to the memory of so talented a man, so modest and unassuming, and so good a friend. His work ceased just at the time when it had come to fruition.

M. E. COOLEY.

BEFORE the construction of the physical property of a utility can be begun, even before the engineering and other plans for that physical property are begun, there are certain preliminary steps necessary to be taken which involve much effort, time, and expense, and which are incurred at much risk of entire loss before the project as a whole can be said to be finally launched. These steps embrace the company's rights from the public, arrangements for the necessary capital funds with which to reimburse itself for preliminary outlays, and funds with which to construct the physical property necessary to fulfill obligations to the public incurred and incident to its rights to conduct a public-utility business.

I will outline these preliminary and necessary steps, state their reasonable costs, and the basis of my estimates. Each indicated percentage, or their sum, should be applied to the total direct and indirect construction cost, including administration and law expenditures, interest, and taxes during construction. I have placed them in three groups:

A—The Development of the Project	2½ per cent
B—The Cost of Money	5 per cent
C—The Promoter's Remuneration	5 per cent

Inasmuch as the preliminary effort, time and expense, the cost of money and the promoter's just remuneration vary proportionately with the breadth, the scope, and particularly the magnitude of the property, they may most conveniently be expressed as percentages of the cost of producing a new property or the estimated cost of reproducing an old property. These three groups are as absolutely essential to the service of the public as the physical groups themselves. Indeed, the latter are only made possible by the former.

A—THE DEVELOPMENT OF THE PROJECT

The items listed below are intended to show in barest outline, by headings, the nature of the preliminary problem. It is not intended to list specifically each and every feature detail, nor can I possibly estimate in detail what each item has or would reasonably cost because the items are all so interrelated and interdependent that no sharp line can be drawn between them. We can, however, estimate upon the cost of this group as a whole, with reasonable accuracy.

1 Conception of the project
2 Determination of its scope and territorial breadth
3 Preliminary outline design and preliminary estimates of cost
4 Estimates of operating expenditures, of operating revenue and resulting profits
5 Prospectus or description of the project
6 Development of the financial plan
7 Legal and other advice
8 Negotiations with bankers and underwriters for capital funds
9 Negotiations with state and community governmental bodies necessary to secure the state charter, franchises, and the approval of the franchises, prospectus and financial plan by the Board of Public Utility Commissioners, and other such matters; but not including any payments to the public for the public rights, nor including any valuation of those public rights.

The old accounting systems were never kept in sufficient detail to show the costs of this group, which I call "Development of the Project." In recent years, however, there have been instances where such costs are approximately known, and there have been many estimates and allowances made by commissions and courts. The percentage allowed on the cost of physical property has, as a rule, fallen within the range of from 2 to 4 per cent, according to the size of the property and state requirements.

The first question, therefore, is how reasonably to estimate the cost of these preliminary requirements as if they were to be incurred as of the present day with the construction of a great public-utility system in view. The necessity for the preliminary work and studies is patent to anybody; the law of the state makes them absolutely essential. That they will cost a great sum of money is obvious; and equally so that the amount involved will be approximately proportional to the magnitude of the project. At this stage of consideration the property being appraised must be looked at as a project; it cannot become a reality until after the preliminary steps have been taken.

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[1] Deceased.

The work involved in the development of the project is performed by the same type of men as are concerned subsequently in the administration of the construction of the property and later in its operations. From general experience we know that the effort and time involved would at least quite equal that incident to the physical construction of the projected utility; and it may be fairly assumed that the expenditures involved in the development of the project would be substantially equal to the cost of the administration and legal expenses during construction. Therefore I have so estimated it.

It costs about the same to administer the expenditure of a million dollars properly, for whatever purpose the money be spent. If during a year the expenditures of a utility corporation for operations and for new property amount, say, to ten million dollars, and if in the same year the administration and legal advice costs $250,000, or $2\frac{1}{2}$ per cent of the money expended, that percentage may reasonably be taken to represent the cost of administration and legal advice during the construction of the property; and it may also be taken to represent the cost of the development of the project, for the reasons given in the preceding paragraph. I have found from a study of public-utility companies' accounts that at least $2\frac{1}{2}$ per cent of the money spent for operating and for construction was the cost for administration and legal expenses, as I am here using these terms.

This method of estimating the costs of development of the project would only fall into error where there are some peculiar or unusual conditions, as in a particular state. In some states there are certain conditions which make for a lesser cost of securing the public rights, gaining approval of them and of the financial and other plans; and in other states the public requirements are such as to increase these costs. In some states, for some kinds of utilities, no local franchises are necessary; in other states there is still no controlling body like public utility commissions. Where there is no occasion to obtain approval of any local franchises, or of any project with its prospectus and financial plan, the preliminary costs are correspondingly less. But where separate charters, corporations, and other forms are necessary in each political subdivision of the state, and the necessity exists for securing approval of the controlling body, for each subdivision, the preliminary costs are correspondingly more.

B—Cost of Money

In order that money may be secured for a particular enterprise, such as a public utility, there must be a cost incident to its acquisition; not only a cost incident to the acquisition of the first money needed, but for each enlargement of the property. This is always true of every such enterprise and always will be. This cost of money is sometimes, in fact, is usually, merged in and becomes a part of what is generally termed "discount" on such bonds and stocks as are sold.

I am here referring only to that part of discount which is incident to the expense of procuring the money with which to construct. The corporation might sell its securities "over the counter," which would involve an expense, or they might employ agents for the disposition of their securities (employing the word "security" to include stocks, notes, etc., as well as first-mortgage bonds), commonly known as brokers, underwriters, bankers, etc.

When we wish to rent or sell real estate we employ a real-estate agent to do it for us because that is his business and he can do it and make a profit at a less cost, or to better advantage, than we could ourselves. There is a cost in either case attendant upon each such transaction, i.e., the value of our own time and effort taken from our own ordinary occupation versus the payment of money to an agent whose ordinary business it is.

Funds with which to construct a property of any considerable magnitude are invariably and necessarily secured from the world's money markets. No locality, or no one market, would be sufficient for the needs of a large enterprise. Funds from these world money markets are invariably supplied through bankers or underwriters, who for themselves make an investigation of the property from the engineering, legal, and commercial points of view. They must bear this expense as well as the expense of selling to the ultimate buyer. They must also assume the risk of changes in the financial situation, or of error in judgment as to the salability of the securities and the price that they will command at such times as the corporation needs the funds. Not infrequently the banker or underwriter is compelled to carry issued securities of a high-grade character for long periods, while the utility gets its money as needed. The public's demand for service cannot be denied whether the money market is favorable or unfavorable. The practical necessities of the case make it wise for a utility company to secure its funds through agents or underwriters who assume the burden of the risks and the expense of reaching the widest, greatest world's money markets. The cost of money is by no means "velvet" to the banker or others who underwrite an "issue."

During the past two years I have been under the necessity, and have had the opportunity and facilities, of informing myself as to the cost of acquiring money in the case of sixteen large and well-known utility companies, with nineteen issues of the highest grade bonds, rated in Moody's Analysis of Public Utilities as "AA" or "A," and marketed within the period from 1908 to 1914. The result of my investigations was to find that the cost incident to the disposition of the senior ("AA" or "A") highest rated securities of these large, well-known utilities was 5 per cent; the discounts were much more than that. The cost incident to selling bonds rated by Moody as "BA" and "BAA," found in the same manner, was 7.9 per cent.

The propriety of allowing this item as one of the proper elements entering into the fair value of a utility has been favorably passed upon by commissions and courts in this country, but the clearest and most complete analysis is that of the English Justice Lawrence in the Railway and Canal Commission, Royal Courts of Justice, in the condemnation case of the National Telephone Company, Limited, vs. His Majesty's Postmaster General. This covers the questions so completely that I quote from that part of the decision dealing with the cost of money.

> The first question then is, would it, in fact, cost anything to provide the necessary capital? The Company have given evidence by way of example, that it cost them 4.41 per cent to raise 5 1-2 million pounds. No one has given evidence that it would not cost anything, nor has that proposition been put forward even in an argument. I know of no commodity and of no service that can be procured as of right for nothing.
>
> It has been said that it cannot be an element adding to the value of the plant. The thing transferred here is the plant "in situ," and the cost of construction, less depreciation, is the method by which the value has to be ascertained. It follows that every expense which is necessary in order to construct is an element to be considered, and it has to be considered because it is necessary in the process of construction. The thing to be transferred, say a pole, must be procured, transported, and erected; each of these steps is necessary to the existence of the pole "in situ"; each of these steps cost money, and raising this money is itself an expense and is one as necessary to the existence of the pole as any of the other steps.
>
> *The cost to be considered is the cost to the hypothetical constructor who is a person in good credit*, or, in other words, what it must cost any constructor. This does not involve the conclusion that the cost of raising capital should be added to the price again if the property should be transferred a second or a third time; it is an item of value once and once only, namely on the construction of the plant, and it is merely because it is necessary in order to construct that this item comes into the calculation at all. That it must be included is apparent, if it is tested in a case in which the sale takes place immediately upon the completion of the construction.

I call special attention to the sentence italicized by me: *The cost to be considered is the cost to the hypothetical constructor who is a person in good credit.* With this part of the decision I personally do not agree when applied to establishing a fair value for another company differently situated. The Board of Public Utility Commissioners does not deal in condemnation or confiscatory matters, but does deal in matters establishing a fair value, among others. "Fair" means more than that which just avoids being confiscatory.

It is obvious that the cost of money is greater on that part of the capital raised on the junior securities than on the senior securities; greater for small undertakings less well situated with respect to the money markets than for large properties very well situated; greater for securities of any class of low rating, than for those of the very highest rating. It does not seem fair to me, therefore, that the allowed cost of the money with which to construct should in all cases be only that allowed in the most favorable circumstances. It follows in my judgment that the fair cost of money necessarily raised for a new enterprise, or for a utility whose securities are not of the highest standing, would be more than 5 per cent—as high as 7.9 per cent. That is the percentage which I found it had cost to sell bonds rated by Moody as "BA" and "BAA."

Securities issued by a corporation under a general mortgage are often classed as "Collateral Trust Bonds." They represent fairly the average, or the mean, of the credit attaching to the various senior and junior security issues of such a corporation necessarily issued to raise all the money needed to construct the whole property. The highest-grade first-mortgage bonds rated in the "A" group by Moody probably could not be sold in amount more than 60 per cent of the total money required. The remaining 40 per cent would have to be acquired through the issue of other forms of junior securities such as common and preferred stocks, second-mortgage bonds and collateral-trust bonds or notes. It costs less to sell the former than it does the latter for the reason that the first mortgage for a limited amount relative to the size of the property has a higher credit than the junior securities. A first-mortgage bond such as I have described absorbs in addition to its own proportion of the corporate credit, all the credit underlying the junior securities as well, and leaves all the risk of the business upon the shoulders of the junior securities in varying degrees according to their degree of juniority. Therefore, when the cost of money with which to construct the whole property is taken as that which it would cost to sell only 60 per cent of the most precious, most easily sold part of the securities, it in my judgment amounts to confiscation of a part of the cost of money involved in raising the rest of the necessary capital funds. That is why I think that usually the fair amount to allow would be more than 5 per cent and might easily be 7.9 per cent of the cost of the property devoted to the public use.

However, under the most liberal interpretation of the phraseology of Mr. Justice Lawrence's decision in the condemnation case referred to, it is the cost of money with the best of credit which is to be considered; therefore, the measure I adopt as the "cost of money" with securities rated "BA" or "BAA," is the cost of capital funds secured for utilities of the highest credit, best salability, such as first-mortgage monds rated "AA" or "A." I take this as the measure in order that my estimate may be regarded as ultraconservative, that it may be accepted as the very minimum.

I arrive at 5 per cent as the cost of money in the following manner: Let us assume that the securities are sold at less than par, or less than their face value. A part of the difference from par is due to the cost of obtaining the money. This part, as I have shown, belongs to the cost of construction and is therefore proper to capitalize. The remaining part is an interest adjustment necessarily made to satisfy the money markets at the moment of sale, which is true discount and may not be a proper capital charge.

Whatever the interest adjustment, whether discount or premium, it is easily determinable as it is the amount less or more than par, or face value, at which the securities are taken by the general public or ultimate purchaser. The cost of money is the difference between the price paid by the ultimate purchaser and the net amount received into the "till" of the corporation. If securities are sold to the ultimate purchaser at above par it simply means that the par, or face interest, is higher than necessary to satisfy the money market. The same security is sold sometimes above par and sometimes below par, according to the demands of the money market at the moment of sale. Money is a commodity which varies in its market requirements much as wheat and other commodities vary. The cost of money, however, is distinct from discount or premium and is the difference between that paid by the ultimate purchaser and the amount received into the corporation till.

As it is the cost of raising all the money which it would take to construct at the present time, the per cent of the cost of money is to be applied to the entire estimated cost of construction. Generally speaking, the money with which to construct is secured through the sale of various kinds of securities—common stock, preferred stock, second-mortgage bonds and notes, as well as first-mortgage bonds. Let us assume three examples:

Example 1:

Par value of bond	$1000
Interest, per cent	5
Bond sold to ultimate purchaser for	975
Net amount received into corporation till	925
In such a case the cost of the money would be the difference between $925 and $975, viz., 5 per cent, which is properly capitalized	50
The interest adjustment required by the money market would be a discount of 2 1-2 per cent	25

Example 2:

Par value of bond	$1000
Interest, per cent	5
Bond sold to ultimate purchaser for	1030
Net amount received into corporation till	980
In this case the cost of the money would be as in the first example, 5 per cent, properly capitalized	50
The interest adjustment required by the money market would be a premium of 3 per cent	30

Example 3:

Par value of bond	$1000
Interest, per cent	4
Bond sold to ultimate purchaser for	800
Net amount received into the corporation till	750
Here again the cost of money properly to be capitalized would be 5 per cent	50
The interest adjustment required by the money market would be a discount of 20 per cent to adjust the assumed market requirement of 5 per cent interest	200

In arriving at my conclusions as to the cost of money I first took the per cent cost incurred in the sale of each of the 19 issues rated at "AA" or "A" of the 16 corporations and found that by adding together the per cent costs and dividing the sum by the number of issues the true average cost was 5.1 per cent. I then multiplied the par value of each issue sold by the per cent cost incurred in that particular sale which gave me the cost in dollars for each case; and by adding all these together I found it had cost $3,164,000 to market $64,845,000 par value of bonds, or 4.9 per cent; 5.1 per cent being the average of the percentages; 4.9 per cent being the weighted average. I took the mean, or 5 per cent, as representing the cost of obtaining money. I found in a similar way that the cost of marketing the "B" group of bonds was 7.9 per cent.

C—Promoter's Remuneration

"I know of no commodity and of no service that can be secured, as of right, for nothing."—Mr. Justice Lawrence. What is it which would induce any promoter or any group of persons to make such a preliminary expenditure as I have described under "development of the project" and then provide the money and assume the two great risks: First, that the project would fall by the wayside and never come to fruition at all; second, its failure afterward? Why should the promoter render such a service as has been rendered to the public in providing most existing utilities? The answer is: Remuneration for service rendered. Promoter's remuneration, as dealt with here, is the cost to the public for the promoter's services. It is entirely distinct from the cost of the preliminary development of the project and the cost of securing the money with which to build the property.

There must be some inducement to bring about the activities of the promoter in the particular enterprise, and that inducement is profit or gain; and for it he renders a valuable service. The service of the promoter is essential at all stages of the utilities' development, not only in the beginning, but with the addition of each increment of capital needed for enlargement or extensions. Enterprise without the service of a promoter is inconceivable. The Railroad Securities Commission appointed by President Taft, of which Arthur T. Hadley, President of Yale University, was Chairman, said on page 30 of their report.

> We are told that the profit of the promoter represents a wholly unnecessary burden upon the American public, and that so far as this

> profit can be done away with it will be good for all parties. Neither of these statements is quite true. The promoters, using the term in a broad sense, may be divided into two classes: constructors who build a railroad whose future is uncertain, in the expectation of selling the stock for more than it cost them; and financiers who induce the public to buy the bonds of such roads. Both of these classes, if they do their work honestly, render useful service to the public. The constructor gives our undeveloped districts the benefit of new roads, which they would not get without his intervention; and if he does his business well he builds the road more economically than anybody else could. The financier renders an equally important service in collecting the capital of the investors to build new railroads or improve old ones.

There are many similar statements made by commissions, courts, and other authorities, and I think all commissions have recognized that the services of a promoter should be properly remunerated.

When a public-service commission is determining the fair value of a property, it should make no difference whether the property is old and has been rendering a valuable service, or whether it is new and much desired by the public; the same elements should enter into the value on which earnings are allowed; and whatever is a proper allowance necessary to induce new and valuable enterprise must also be a proper allowance to give the promoters of an enterprise already in existence and of undoubted public use and in which the risk has been incurred and the service rendered.

The service of a promoter having been essential to a particular utility, the property having been built and having rendered a valuable service to the community, it is entirely proper that a reasonable recompense should be made on account of the service of promotion. The fact that the promoter might be the present owner does not in any way affect the equity. If now, when the state for the first time fixes the value and exercises control over the property, it denies remuneration to the promoter an injustice will be done. The promoter, indeed, might better have gone elsewhere.

In the application of the Rochester, Corning and Elmira Traction Company for consent to the execution of a mortgage, and authorizing the issuance of capital stock, the Public Service Commission of the State of New York, 2d District (opinion by Chairman Stevens, in Vol. 1 of the report of April 1, 1909, p. 166), dealt with the whole subject very fully (as it has been by many other commissions) and allowed 5 per cent as promoter's remuneration. It has also allowed 5 per cent in the case of other projected utilities.

In the decision by Chairman Stevens, in the case referred to, he speaks of the difficulty of determining the exact amount which the promoter should be paid under the varying conditions. He fixed 5 per cent for a proposed railroad, the desirability of which he had passed upon favorably. My judgment is that his allowance was too small for such a new project (the road was not built), yet he is a man intentionally fair, of good judgment, and has had good opportunities for observation. Five per cent has been accepted in other cases and is a frequent minimum provision in promoting large enterprises. Therefore, it follows, and my judgment is, that five per cent of the cost of a property is the minimum proper capital allowance which should be made, in the appraisal of public utilities.

The Construction Period

By H. C. ANDERSON,[1] ANN ARBOR, MICH.

IN the early days of appraisals, the item of interest during the construction period was frequently ignored. In some of the later appraisals it has been taken at very large figures, large because of the assumption that the construction period extended to the completion of the entire property; that is, no part of it was assumed to go into operation before the completion of the whole. There seems to be very little, if any, disagreement among engineers and commissions as to the annual rate of interest, but in many cases there is a wide variation in the length of the construction period.

If it is assumed the property is to be reproduced "piece-meal" we will have one period of construction. On the other hand, if the property is to be reproduced "wholesale" we will have a different period of construction. If a certain property is to be reproduced "piece-meal" the result would naturally be higher unit cost and lower total interest cost than if reproduced by the "wholesale" method. In some cases the two may balance.

The particular part is to fix, as accurately as possible, the duration of the construction period. Usually some part of the property, a power plant for instance, will be the best guide. Obviously, a street railway, complete in every other respect, must remain idle without power.

The question of the critical speed of construction must be given consideration. Theoretically, a large property could be constructed in a few months, assuming enough men and material could be procured; but to do this it would be necessary to exceed the speed of economical construction, which would result in a very high unit cost, and no doubt would more than offset the decrease in the interest cost. Consideration, also, must be given to the question of obtaining labor and material in large quantities at the time desired, and the fact that no city would consent to the extensive tearing up of its streets that might be necessary with a short period of construction.

One method often used is to assume an interest rate of 6 per cent applied to the entire cost over one-half the construction period. The cost is zero at the beginning and is assumed to increase uniformly to the full amount at the end. A criticism of this method is that money cannot be borrowed day by day, or month by month, as needed. It is difficult to imagine bankers willing to furnish money in this way.

Another method often used is to assume an interest rate of 6 per cent and 2 per cent allowance on the unexpended balance, assuming the unexpended balance to equal one-half the loan, and the loans to be made at equal intervals during the construction period. The following concrete problems will illustrate the two methods.

PROBLEM No. 1:

Assume a property costing $12,000,000 and a construction period of three years, interest rate 6 per cent. The expenditures proceeding uniformly from zero at the beginning to the full amount at the end.

Solution:

Six per cent for one-half the construction period will give a total interest charge of 9 per cent, this applied to the $12,000,000 cost will give $1,080,000 as the interest cost.

$$\frac{1,080,000}{12,000,000} = 9 \text{ per cent}$$

PROBLEM No. 2:

Assume a property costing $12,000,000 and a construction period of three years, interest rate 6 per cent, allowance on balance at the rate of 2 per cent, balances equal one-half the loan. $2,000,000 borrowed each six months.

Solution:

First loan	$2,000,000 @ 6% for 3 yr.	$360,000	
Credit on balance...	1,000,000 @ 2% for ½ yr.	10,000	
Net interest first loan..................			$350,000
Second loan	2,000,000 @ 6% for 2½ yr.	300,000	
Credit on balance...	1,000,000 @ 2% for ½ yr.	10,000	
Net interest second loan................			290,000
Third loan	2,000,000 @ 6% for 2 yr.	240,000	
Credit on balance...	1,000,000 @ 2% for ½ yr.	10,000	
Net interest third loan..................			230,000

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[1] Professor of Mechanical Engineering, University of Michigan, Mem. Am. Soc. M. E.

Fourth loan	2,000,000 @ 6% for 1½ yr.	180,000	
Credit on balance...	1,000,000 @ 2% for ½ yr.	10,000	
Net interest fourth loan..................			170,000
Fifth loan	2,000,000 @ 6% for 1 yr.	120,000	
Credit on balance...	1,000,000 @ 2% for ½ yr.	10,000	
Net interest fifth loan..................			110,000
Sixth loan	2,000,000 @ 6% for ½ yr.	60,000	
Credit on balance...	1,000,000 @ 2% for ½ yr.	10,000	
Net interest sixth loan..................			50,000
Total interest for three years............			$1,200,000

$$\frac{12,000,000}{1,200,000} = 10 \text{ per cent}$$

If this money is borrowed $4,000,000 each year for three years instead of $2,000,000 each six months the total interest becomes

$$\frac{1,320,000}{12,000,000} = 11 \text{ per cent}$$

It will be noted, in this analysis, the assumption is made that no part of the money is spent until the day construction starts. In actual practice this would be very difficult, if not impossible. The land for various purposes, such as right of way, power stations, sub-stations, shops, car houses, gas plants, commercial offices, etc., would necessarily have to be purchased one or more years before construction started. The following concrete problem will illustrate this method.

Problem No. 3:

Assume a property costing $12,000,000. Of this amount the cost of land is $1,200,000 and the structural property $10,800,000. It will require three years to obtain the land, starting one year in advance of construction. Construction period of three years. Interest rate of 6 per cent, allowance on balance at the rate of 2 per cent, balances equal one-half the loan, money borrowed each six months.

Solution:

If the purchase of land starts one year in advance, and money is borrowed every six months there will be 8 periods to consider; following are the amounts borrowed each period.

	Land	Structural Property	Total
First Period	200,000	....	$ 200,000
Second Period	200,000	....	200,000
Third Period	200,000	$1,800,000	2,000,000
Fourth Period	200,000	1,800,000	2,000,000
Fifth Period	200,000	1,800,000	2,000,000
Sixth Period	......	1,800,000	2,000,000
Seventh Period	$200,000	1,800,000	1,800,000
Eighth Period	......	1,800,000	1,800,000
Total	$1,200,000	$10,800,000	$12,000,000

First loan	$200,000 @ 6% for 4 yr.	$48,000	
Credit on balance..	100,000 @ 2% for ½ yr.	1,000	
Net interest second loan................			$47,000
Second loan	200,000 @ 6% for 3½ yr.	42,000	
Credit on balance..	100,000 @ 2% for ½ yr.	1,000	
Net interest second loan................			41,000
Third loan	2,000,000 @ 6% for 3 yr.	360,000	
Credit on balance..	1,000,000 @ 2% for ½ yr.	10,000	
Net interest third loan..................			350,000
Fourth loan	2,000,000 @ 6% for 2½ yr.	300,000	
Credit on balance..	1,000,000 @ 2% for ½ yr.	10,000	
Net interest fourth loan			290,000
Fifth loan	2,000,000 @ 6% for 2 yr.	240,000	
Credit on balance..	1,000,000 @ 2% for ½ yr.	10,000	
Net interest fifth loan..................			230,000
Sixth loan	2,000,000 @ 6% for 1½ yr.	180,000	
Credit on balance..	1,000,000 @ 2% for ½ yr.	10,000	
Net interest sixth loan.................			170,000
Seventh loan	1,800,000 @ 6% for 1 yr.	108,000	
Credit on balance..	900,000 @ 2% for ½ yr.	9,000	
Net interest seventh loan................			99,000
Eighth loan	1,800,000 @ 6% for ½ yr.	54,000	
Credit on balance ..	900,000 @ 2% for ½ yr.	9,000	
Net interest eighth loan................			45,000
Total interest cost			$1,272,000

$$\frac{1,272,000}{12,000,000} = 10.60 \text{ per cent}$$

If this money is borrowed at the beginning of each year instead of every six months the amounts for each period will be as follows:

	Land	Structural Property	Total
First Period	$400,000	....	$ 400,000
Second Period	400,000	$3,600,000	4,000,000
Third Period	400,000	3,600,000	4,000,000
Fourth Period	....	3,600,000	3,600,000
Total	$1,200,000	$10,800,000	$12,000,000

The total interest cost will be $1,392,000.

$$\frac{1,392,000}{12,000,000} = 11.60 \text{ per cent}$$

I do not know of any one formula that can be applied to every type of utility, and which, when solved, will give accurately the interest cost during construction. Each property will have its own individual problems, and for this reason a thorough study should be made of the particular property under consideration to determine:

1 The magnitude of the property and the difficulties that must be overcome during construction
2 The method used in finding the reproduction cost
3 The proper construction period, taking into consideration the method used in finding the reproduction cost
4 Knowing the construction period, what is the proper method to use in finding the total interest cost?

In the end, after all theories have been considered. it is the judgment of competent engineers that should be the controlling factor.

Taxes During Construction

Like interest, taxes during construction is an item of cost incurred during the construction period and must be paid, the only question being, what is the proper amount to allow. It may be argued that the value of a utility depends on its earnings, and there can be no earnings during the construction period, therefore no taxes should be paid. But it does not work that way. The assessor finds the land and puts it on the rolls. He finds the building materials, machinery, and partially erected buildings and they also go on the rolls, perhaps not in full amount, but in some amount at least. The problem, however, is somewhat easier than in the case of interest. It is always possible to go to the company's books and find the amount of taxes the company is actually paying, also the rate, but it is not always possible to find the ratio of assessed to actual value.

It also becomes necessary to estimate just what percentage of the property under construction the assessor will find and put on the rolls. It is also necessary to consider whether the date of starting construction and the date of assessment are the same, or whether the assessment is made in mid-year of each year of the construction period. The final result will not be very different with two methods. The following problem is presented only to illustrate the solution under certain assumed conditions.

Problem No. 4:

Assume a property costing $12,000,000, of this amount the

(*Continued on page* 597)

The Design of Aspirators for Sterilizing Water

By A. E. WALDEN,[1] BALTIMORE, MD.

THE value of ozone as a sterilizing agent in the purification of water is well known. The means for uniting water and ozone or air, however, are not so clearly established, and in an effort to perfect the design of an aspirator which would efficiently accomplish this the writer conducted an extensive series of experiments which form the basis of this paper.

From the operating point of view, it was first of all essential that the heads of water pumped against be kept as low as possible. Data were unobtainable, however, concerning the relation of the volume of water to the volume of air that it was possible to combine or mix at low heads, or the possible variation of the two, which is of greater importance.

To obtain this information numerous different forms of aspirators, ejectors, siphons, jets, and nozzles were accordingly tested. Some of these, of the barometric-condenser type used for both steam and water, failed to give satisfactory results. Some that would work successfully with steam would not work with water; moreover, they would not handle large volumes of air. Others that would work well with large volumes of water could not be manipulated to vary the quantity of water and would not handle large volumes of air, or permit of varying the quantity of air to the quantity of water, and vice versa. Also some that were very satisfactory for use with condensers would not handle large quantities or volumes of air with water without a blowback of air, due to the fact that the column of water and air lacked weight or velocity to compress the air and keep the combination in a forward motion, a pressure equivalent to higher pressure than that in the mixing well or contact cell being required.

Experiments likewise showed that under low heads some aspirators would draw in a continuous draft of air but could not be varied; others, when the draft was heavy, would lower the specific gravity of the mixture to such a value that a blowback occurred and action ceased altogether; and that while it was possible to draw in air and water in a proportion of 1 to 3, by volume, the head should not be reduced much below 12 ft. for satisfactory operation. All of the above conclusions were reached by testing many different types and designs of aspirators and the first results that were at all satisfactory were obtained with a Knowles spirojector. This is shown in Fig. 1.

The Knowles spirojector, however, while giving fairly satisfactory results, did not function at low heads any better than other types; moreover, it is difficult to construct in either tile or enameled iron, inasmuch as the heat necessary to set the enamel will warp and distort the tube. If a tile-grinding process could be employed at a reasonable cost, it might be possible to eliminate some of the objections to this form of aspirator, such as the lack of flexibility in the variation of quantity of water, etc. In all cases, however, it was impossible materially to vary the quantity of air and ozone to water, and a pumping head of 34 ft. plus a pressure of 3 lb. per sq. in. was of course out of the question.

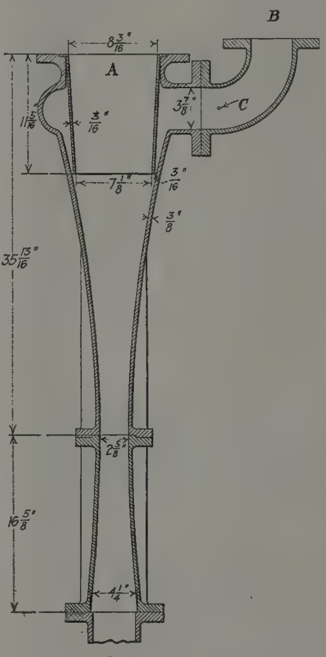

Fig 1

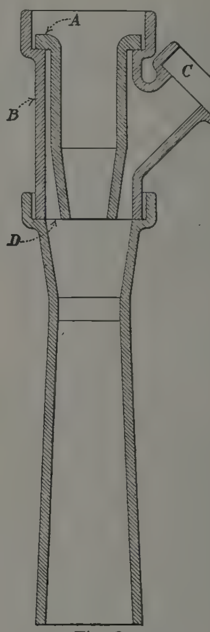

Fig. 3

FIG. 1 SECTIONAL VIEW OF THE KNOWLES SPIROJECTOR
When used as an aspirator, air enters at *A* and water at *B*. When measuring air velocity, opening *A* is reduced and an anemometer placed in the reduced opening. Pressure gage is located at *C*.

FIG. 3 SECTIONAL VIEW OF ASPIRATOR USED IN TESTS

In this connection it should be pointed out that air velocity tends to reduce the temperature and that if the humidity is

TABLE 1 SUMMARY OF RESULTS OBTAINED IN TESTING VARIOUS TYPES OF ASPIRATORS

No.	Type of Aspirator[1]	Discharge, cu. ft. water per min.	Air velocity, ft. per min.	Cu. ft. of air per min.	Pressure head, ft.-in.	Negative head, ft.-in.	Bacteria, per cent removal
1	3-in. Orifice	41	1100	45.0	5—9	8—0	97.58
2	3-in. Orifice	41	1090	44.7	6—0	8—0	85
3	2.5-in. Orifice	41	930	38.0	5—10½	8—0	95.6
4	3.5-in. Orifice	41	900	36.9	5—1	8—0	88.1
5	Tile Aspirator	41	1000	41.0	6—2	7—0	92.0
6	Nozzle 2-A, Throat No. 2, 2⅛ in. apart	24.5	590	24.1	5—8¾	7—0	98.8
7	Nozzle 2-A, Throat No. 3, 2⅛ in. apart	25	420	17.2	6—2	7—0	98.8
8	Nozzle 2-A, Throat No. 4, ⅛ in. clearance around jet at throat	24	870	35.6	6—1	7—0	99.2
9	Nozzle No. 2-A, Throat No. 3	23	630	25.8	6—3	7—0	98.6
10	Nozzle No. 2-A, Throat No. 5	25	335	17.7	6—4	7—0	95.9
11	Nozzle No. 21, Throat No. 25	42	330	13.5	5—4	7—0	97.3
12	Nozzle No. 21, Throat No. 22	42	430	17.6	5—4	7—0	99.1
13	Nozzle No. 21, Throat No. 23	42	690	28.2	5—2	7—0	99.3
14	Nozzle No. 21, Throat No. 24	42	800	32.8	5—3	7—0	97.2
15	NozzleNo. 21, Throat No. 6	42	460	18.8	5—4	7—0	98.3
16	Nozzle with holes of 5 sets, Throat No. 25	22	725	29.7	6—1	7—1	99

[1] Tests Nos. 1-4 were made with a steel-plate orifice inserted at *D* in Fig. 3.
Test No. 5 was made with a tile nozzle inserted at *D* in Fig. 3.
Tests Nos. 6-16 were made with nozzles and throats of the shapes shown in Fig. 2.

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[1] Supt. and Chief Engineer, The Baltimore County Water and Electric Co., Mem. Am. Soc. M. E.

high and the air impinges on a cold metal surface, such as a cooled tube, the dewpoint is quickly reached and moisture is immediately precipitated on the cool surface. If allowed to continue it eventually causes rupture of the dielectric in the ozone generator. Humidity also reduces the quantity of ozone it is possible to produce. The reason therefor is not known at this time, unless it may be that moisture carries the static charge in such a way as not to affect the air itself. The above action, which has never before been mentioned by any experimenters, was accidentally discovered during the series of experiments conducted by the author.

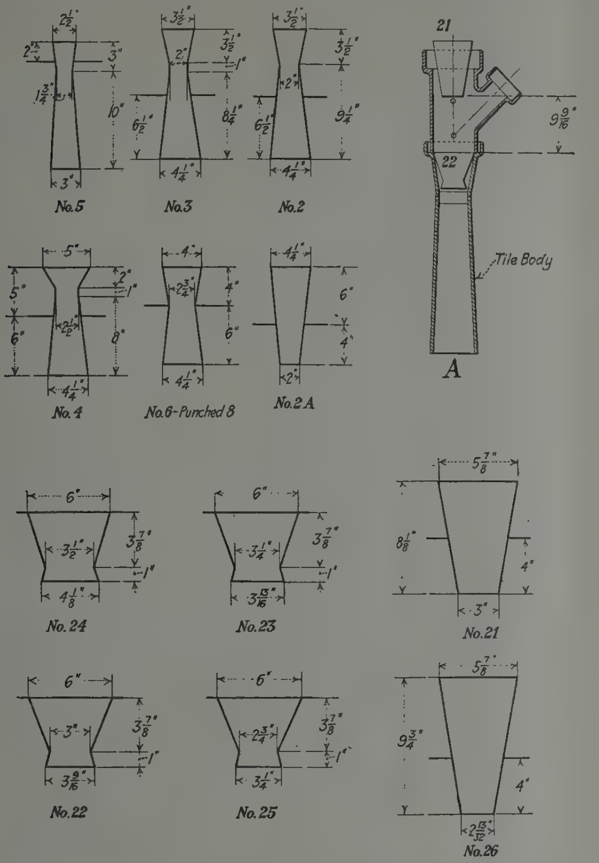

Fig. 2 Experimental Aspirator with Tile Body and the Various Nozzles and Throats Used

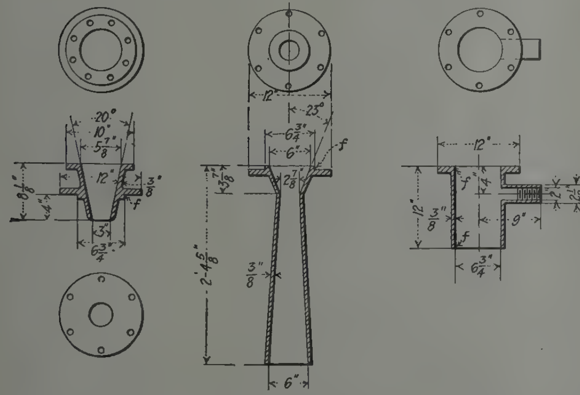

Fig. 4 Details of an Aspirator Head

As a result of these preliminary tests a new set of experiments were conducted using various tile nozzles and different throats inserted in a tile body as shown at *A* in Fig. 2. These nozzles and throats are also shown in Fig. 2. The results of the experiments conducted on these aspirators are given in Table 1, and the varied tests indicated therein show the successive steps which were taken in the selection of the type ultimately chosen.

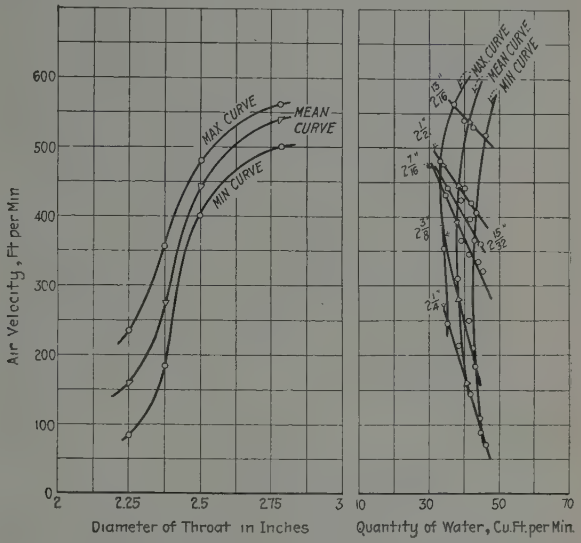

Fig. 5 Curves Showing Relation of Air Velocity to Diameter of Throat and to Quantity of Water with Varying Sizes of Throats (For 20-deg. 3-in. Nozzle)

The Effect of Varying Head

A series of tests were also made to determine the effect of varying both the positive and negative head, positive head being the elevation above the throat and negative head the distance from the throat to the tailwater. The results of these tests are given in Table 2 and summarized below.

The loss of 4 in. down the pipe, or tail pipe, was estimated to be equal to 0.08436 ft. per foot of pipe.

A test was made for the 2-in. nozzle for diameter of stream at contracted portion, which was found to be 1 13-16 in. at one-half the distance of 3 in. from end of nozzle; and discharging 33 cu. ft. under 5.75 ft. positive head and 7 ft. negative head sustained a column of water 81.5 in. high. Roughness or irregularity of the apparatus used, however, will vary these figures materially.

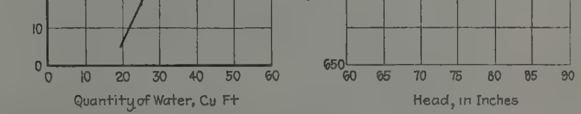

Fig. 6 Curves Showing Relation of Head to Quantity of Water and Air Velocity, for 20-deg. 3-in. Nozzle

These tests indicate that the length of the jet discharged from the nozzle striking either at the throat or at some point in the diverging tube below the throat gave the best results. As the tests were made the jets were examined by throwing light through the opening *C*, Fig. 3, so that the jet could be seen, and also through a side opening, which was straight, in a cast-iron special that was employed in place of tile *B*.

In every case the roughest discharge from the nozzle, if it impinged at or below the throat, drew in the greatest quantity of air. This led to the suggestion that a glass aspirator be constructed, but glass manufacturers would not undertake to make it except at an excessive price.

The appearance of the jet also suggested that possibly a nozzle giving a star-shaped or serrated surface discharge would aspirate a greater quantity of air to a given volume of water.

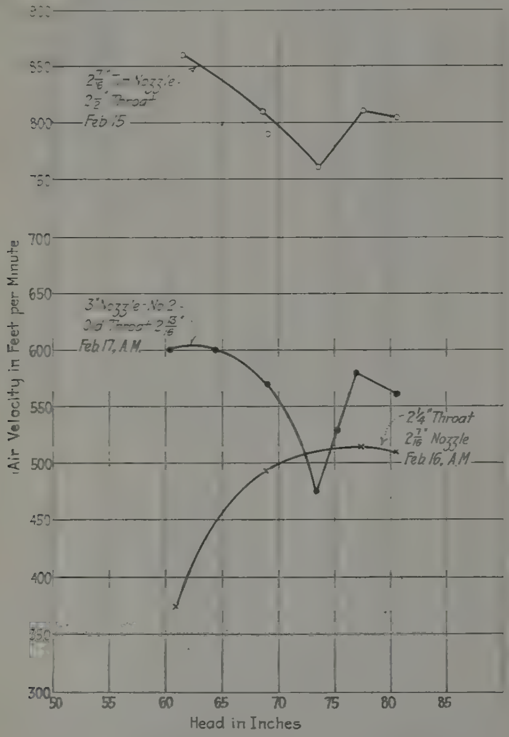

Fig. 7 Curve Showing Irregular Characteristics Found in a Few of the Large Number of Aspirators Tested

These experiments led to the construction of three aspirators, one of which was later adopted and is shown in Fig. 4.

TABLE 2 RESULTS OF TESTS MADE TO DETERMINE EFFECT OF VARYING HEAD

No.	Type of Aspirator.	Discharge Cu. ft. Water per Min.	Air Velocity, Ft. Per Min.	Cu. Ft. Air Per Min.	Pressure Head, Ft. In.	Negative Head, Ft. In.
1	Tile Nozzle, Throat No. 22 ..	42	1015	41.6	7—0	7—0
2	" " Throat No. 25 ..	42	890	36.5	7—0	7—0
3	3-in Nozzle, 2⅞-in. Throat...	47	420	17.4	6—0	8—0
4	" " ...	46	380	15.6	6—0	8—0
5	" " ...	47	275	11.5	6—0	7—6
6	" " ..	47	200	8.2	6—0	6—0

All of these tests indicated the importance of providing not less than 20 per cent excess air velocity in testing over that in operation in sterilizing, to allow for friction in tail pipe and mixers or devices below the throat, including the change in the specific gravity of the mixture of air and water. This was necessary to keep the mixture in motion.

It was the intent to carry out further experiments to determine what would appear to be the slip of the bubbles of air in the tail pipe and the fact that they do not seem to fall at the same velocity as the column of water, or for some reason do not receive and hold the kinetic energy imparted to them. The bubbles decrease in size with increase of head and increase with a decrease of head, which is as it should be. The bubbles appear to rise at a rate of about 0.75 ft. per sec.

The specific gravity of the mixture of air and water, or ozone, when a certain entrainment is reached, is so low that the energy in a downward direction is lost and a blowback occurs in the air inlet, as before mentioned, which is similar to the air lift, and makes the mixture look like soap bubbles in the down pipe.

The Type of Aspirators Adopted

The final aspirators were of cast iron, enameled with the best possible white porcelain enamel; but even this is subject to deterioration, due to high ozone concentration, which shows after about five years of operation. There seems to be no question as to the suitability of tile for aspirators when ground to suitable measurements.

The details of an aspirator head are shown in Fig. 4. The curves of Fig. 5 and 6 give its characteristics. Some experiments, however, would seem to indicate that the air intake and the time element of mixing might be changed profitably, considering the cost of handling the water, and that contact in a horizontal pipe beyond the tail pipe for a distance of 20 ft. will turn out a perfectly satisfactory effluent. The curves in Fig. 7 are inserted to show the irregular characteristics found in a few of the great number of aspirators tested before the final type was chosen.

John Ericsson Memorial Tablets

The members of The American Society of Mechanical Engineers doubtless remember the account published in the January 1920 issue of Mechanical Engineering of the memorial meeting held during the Annual Meeting of this Society, on the evening of December 3, 1919, in commemoration of the eightieth anniversary of the arrival in the United States of Captain John Ericsson, his fifty years' association with Cornelius H. DeLamater in engineering work, and finally the thirtieth anniversary of the deaths of these two men in 1889 within one month of each other.

It had been decided previous to the memorial meeting that money left over from subscriptions to it should be set aside as a nucleus for a fund to be devoted to the erection of commemorative tablets to mark the sites of certain buildings which were closely identified with the work of Mr. DeLamater and Captain Ericsson. These buildings comprised: (1), the Phoenix Foundry at Laight and West Streets, New York City, where the first screw-propelled vessel in this country was constructed and where many other original developments were made; (2), Captain Ericsson's residence, 26 Beach Street, where he designed the *Monitor* and made all his inventions during his later years; (3), the DeLamater Iron Works, foot of West 13th Street, where the engines of the *Monitor, Puritan* and *Dictator* were constructed, as well as the first submarine boat, the first torpedo boat, the first torpedo boat destroyer, the first self-propelled torpedoes, the first dynamite gun, the first air compressors, ice machines and many other industrial appliances now in general use throughout the world; (4), the Continental Iron Works at Greenpoint, L. I., where the hulls of the *Monitor*, the *Puritan* and other warships were built.

A number of organizations have already subscribed to the tablet fund, either as a body or through individual members. The tablets will be unveiled on March 9, 1922, the sixtieth anniversary of the battle between the *Monitor* and the *Merrimac*, on which date also the John Ericsson Memorial Monument will be dedicated in Washington.

The individual members of the Metropolitan Section have been asked to subscribe to this fund, but it is believed that there are many members, as well as industrial firms, organizations and other individuals, located elsewhere who, from sentimental or patriotic motives, would also like to subscribe. Those interested should communicate with the DeLamater-Ericsson Tablet Committee, H. F. J. Porter, Chairman, Room 1100 Engineering Societies Building, 29 West 39th Street, New York, N. Y.

The Effect of Depth of Copper Plating on Carburization

By F. P. ZIMMERLI,[1] ANN ARBOR, MICH.

ALTHOUGH case hardening has been investigated considerably during the last few years, methods for preventing the cementation of steel in certain areas have received but little attention. Commercial plants which the writer has recently had occasion to visit have called his attention to the importance of the use of non-carburizing materials and the lack of knowledge concerning them. Most of these plants were using copper plating on all parts of the steel not to be cemented and in answer to inquiries regarding the amount used, the general reply was that they put on "enough."

While there are several non-carburizing materials in use, such as fireclay, or waterglass and calcium hydroxide mixed to form a paint, nevertheless copper plating has given the most satisfaction and it is estimated that it is employed by at least 75 per cent of the plants.

The object of the work described in the following paragraphs was to determine the least amount of copper which must be plated on a piece of steel in order that within a specified time no carbon shall have penetrated through the coating and gone into the steel.

The steel chosen for the experimental work was 3/4-in. bar stock having the following percentage composition: C, 0.112; P, 0.012; S, 0.0365; Si, 0.128; Mn, 0.458. This was cut longitudinally into half-round pieces approximately 0.75 in. by 1.25 in. on the flat side. These pieces were then numbered and the flat sides, approximately 0.94 sq. in. in area, ground smooth and true on an emery wheel. These uniformly smooth surfaces were cleaned and the backs greased preparatory to plating. Pieces Nos. 1 to 10 inclusive were placed in the plating bath at one time and formed the first set, 11 to 20 the next set, etc., the time on each set being different to control the depth of copper plate.

The cyanide bath was made up as follows, the given quantities being for one liter of solution:

Na_2SO_3	20 grams
$Na_2CO_3 10H_2O$	20 grams
$NaHSO_3$	20 grams
$Cu(C_2H_3O_2)_2H_2O$	20 grams
KCN (100 per cent)	20 grams

The specific gravity of such a solution is 1.0507 or 7 deg. B. The current density advised for plating is 0.003 ampere per sq. cm. and the copper deposited at 20 deg. cent. 2.3716 grams per ampere-hour. Because of gas evolution and deposition of copper on the backs of the pieces which no grease would seem entirely to keep off it could not be figured beforehand just how much copper would plate on, nor could the current be kept constant at 0.003 ampere per sq. cm. for each set. An effort was made, however, to keep to this value. It was necessary to guess at the percentage of the total surface exposed by the ten specimens in the bath because of gradual copper deposition on the back. The total area of any one piece was 2.867 sq. in. and of this it was desired to plate 0.955 sq. in.; and of a set, ten times that value.

In practice it was believed that 0.005 in. was not an unusual depth of plate. M. T. Lothrop in his paper on Case Carbonizing[2] reports that 0.0005 in. of copper is the least amount sufficient to prevent carbonization due to non-uniform coating giving unplated areas, but he does not state the current density used. This value he obtained by measurement with micrometers. The plating on the specimens used in this work was from 0.00000896 in. to 0.001815 in. thick, which values are both less and greater than that of Mr. Lothrop.

It was impossible either to figure in advance the amount of copper by knowing the current used as before mentioned, or to obtain the true value of copper deposited by weighing before and after plating, the iron displacing the copper in solution even when no current was used and the moisture condensed on the surfaces was appreciable. The tests were therefore continued as follows: The fifty pieces, sets 1, 2, 3, 4, and 5, depending on length of time in copper-plating bath, were divided so that set A consisted of ten samples, two from each of groups 1, 2, 3, 4, and 5. Sets B, C, D, and E were formed likewise. Two were taken from each of groups 1, 2, 3, 4, and 5 because when ten samples were immersed in the plating bath, five were on each side of the copper electrode. One piece from each side of the electrode for each time interval in the bath constituted a set. All copper but that on the flat surface was taken off. Several 2½-in. iron pipes 8 in. long with caps were obtained and a small hole drilled in each, thus keeping the pressure atmospheric. Sets A, B, C, D, and E were packed in them with a carburizing mixture which analyzed as follows:

Charcoal	48.70 per cent
$BaCO_3$	10.56 per cent
Na_2CO_3	4.65 per cent
SiO_2	2.70 per cent
Al_2O_3	33.25 per cent

The specimens were packed face down in alternate layers with the carburizing material, the container being placed upright, and about an inch of the material was placed over the last specimens placed in a container.

Sets A, B, C, D, and E were carbonized at 1697 ± 3 deg. fahr. in a large gas furnace for 1, 2, 4, 8 and 12 hours, respectively. One-half hour was allowed for the container to reach furnace

TABLE 1 DATA OF TESTS TO SHOW EFFECT OF DEPTH OF COPPER PLATING ON CARBURIZATION OF LOW-CARBON STEEL SPECIMENS

	Piece Number	Time in furnace, at 1700 deg. fahr., hours	Depth (t) of copper deposit in hundred thousandths of an inch.	Depth of case on steel, inches		Case under copper
				Eutectoid	Hypoeutectoid	
Set B	5	2	1.885	0.016	0.0186[1]	None
	10	2	1.850	0.0106	0.0186[1]	None
	15	2	22.79	0.0160	0.0160[1]	None
	16	2	20.80	0.0160	0.0106[2]	None
	23	2	89.25	0.0106	0.0187[1]	None
	29	2	55.25	0.0186	0.0186	None
	33	2	50.20	0.0106	0.0187	None
	38	2	55.60	0.0106	0.0187[1]	None
	45	2	145.50	0.0160	0.0214	None
	49	2	133.50	0.0160	0.0187	None
Set D	1	8	1.29	0.0453	0.0318	[3]
	8	8	1.78	0.0318	0.0318	None[4]
	12	8	17.8	0.0372	0.0266	None
	18	8	12.45	0.0453	0.0318	None
	24	8	76.95	0.0453	0.0318	None
	28	8	70.00	0.0453	0.0318	None
	31	8	53.25	0.0453	0.0342	None
	37	8	56.25	0.0480	0.0342	None
	41	8	144.50	0.0480	0.0342	None
	48	8	158.00	0.0480	0.0342	None
Set E	2	12	0.896	0.0372	0.0532	[5]
	9	12	3.02	0.0532	0.0372	Cu broken[6]
	11	12	20.30	0.0532	0.0532	None
	17	12	11.98	0.0318	0.0266	[7]
	25	12	73.50	0.0590	0.0372	[8]
	30	12	66.00	0.0343	0.0398	None
	34	12	88.25	0.0372	0.0508	None
	39	12	46.70	0.0372	0.0560	[9]
	42	12	163.10	0.0318	0.0508	None
	47	12	124.10	0.0560	0.0398	None

[1] Uneven. [2] Very uneven. [3] Raise of 0.11 to 0.2 per cent C at extreme edge near copper. Copper off in places. [4] Copper off in places. [5] Raise of 0.11 to 0.15 per cent C at extreme edge near copper. Copper mostly off. [6] Copper off in places. [7] Practically none. [8] 0.1 to 0.2 per cent. [9] Raise of 0.11 to 0.2 per cent.

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[1] Department of Chemical Engineering, University of Michigan.

[2] Trans. Am. Soc. M. E., vol. 34 (1912), p. 939.

temperature and it took the furnace 10 hr. to cool down to 291 deg. fahr. after being shut off, at which temperature the sets were removed from the furnace.

Upon opening the containers all specimens were examined for oxidation of iron or copper. The exposed iron was first coated with paraffin and nitric acid then used to remove all the copper from the surface. The percentage of copper was determined electrolytically. At the time of this analysis it was realized that the iron might have dissolved some of the copper and some might have been carried off mechanically, but it is felt that in this manner there was less error introduced than in any other.

The specimens were all sawed in half, polished and etched. They were then examined microscopically for case depth under the copper plating and on the back where there was no copper deposition. The case was always examined for free cementite, which was not found until Set E was reached, where it occurred in some of the specimens; however, it was so very shallow that it was figured in the eutectoid. The hypoeutectoid was measured to a point wherein it was estimated that there was not over 0.15 to 2 per cent carbon, since from such a low percentage it decreased rapidly to the 0.11 per cent of the original steel.

(Continued on page 602.)

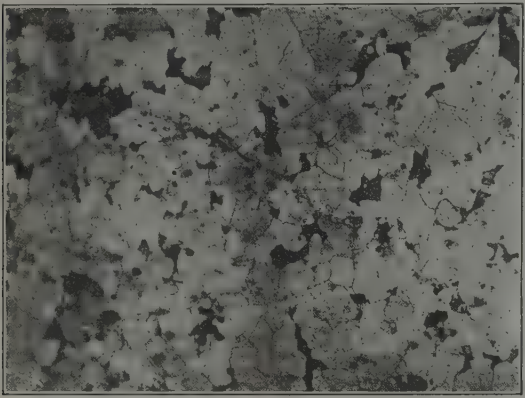

Fig. 1 Photomicrograph of Untreated Specimen Etched with 5 per cent Nitric Acid (× 100)

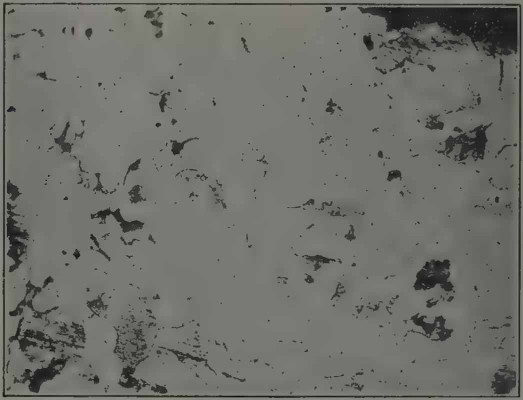

Fig. 2 Under Copper Plating, Showing Edge of Piece. Etched with 5 per cent Nitric Acid (× 100)

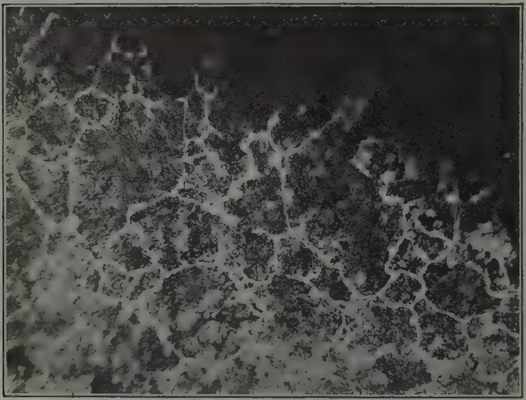

Fig. 3 Unplated Edge, Showing Case. Etched with 5 per cent Nitric Acid (× 100)

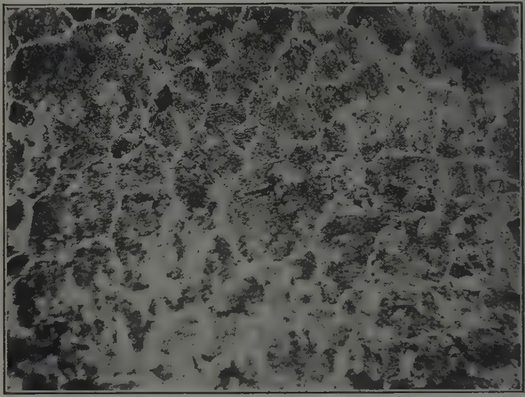

Fig. 4 Same as Fig. 3, Except Farther from Edge of Specimen (× 100)

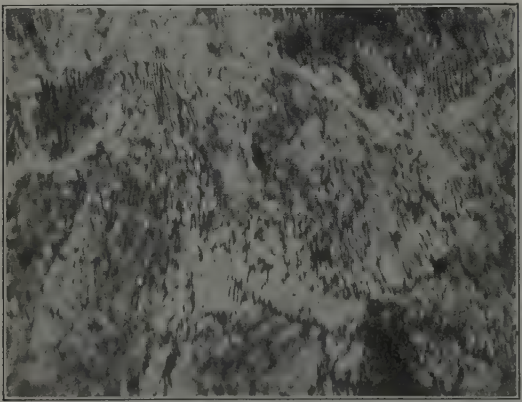

Fig 5 Unplated Edge, Showing Case. Same as Fig. 4 (× 350)

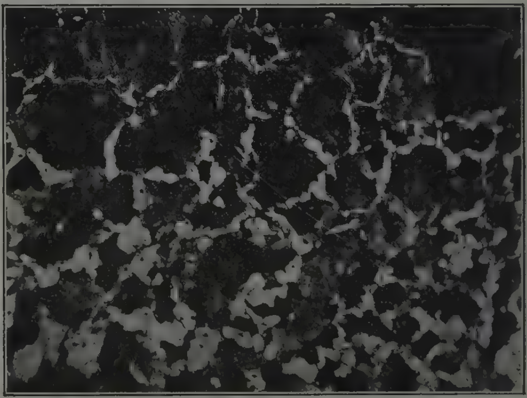

Fig. 6 Case Still Farther from Edge than in Fig. 4

Notes on Electric Welding

At a meeting of the Washington Section of the A.S.M.E. on May 17 of this year, two papers on electric-arc welding were presented, one by Mr. H. S. Rawdon of the Bureau of Standards and the other by Mr. O. H. Eschholz of the Westinghouse Electric & Manufacturing Co. Data are given by these authors on the strength of the joint and the properties of arc-fused metal.

THE ELECTRIC-ARC WELDING OF STEEL: THE PROPERTIES OF THE ARC-FUSED METAL

By HENRY S. RAWDON,[1] WASHINGTON, D. C.

A FUSION weld is fundamentally different from all other types in that the metal of the weld is essentially a casting. The arc-fusion weld has characteristics quite different from other fusion welds. The results of a study of the properties of the arc-fused metal which has been carried out by the Bureau of Standards may be of sufficient interest to warrant presentation before this body. For details the Technologic Paper of the Bureau upon this subject should be consulted.

The application of arc welding in the shipbuilding industry is one of the most important and extensive applications which has ever been proposed for this method. During the year 1918, at the request of and with the coöperation of the Welding Research Sub-Committee of the Emergency Fleet Corporation, an extensive program was outlined by the Bureau of Standards for the study of this type of welding. The principal object of the research was the determination in an empirical way by actual welding tests carried out by skilled operators the relative values and merits of the different types of electrodes or welding pencils which are available commercially for the purpose. Due to changed conditions, however, at the close of the year 1918, the original program was modified and shortened very considerably.

In drawing up the modified program it was decided to make the study of the characteristic properties of the fused-in metal, the primary object of the investigation, the study of the merits of the different types of electrodes being a secondary one. Since the metal of any weld produced by the electric-arc fusion method is essentially a casting, as there is no refinement possible as in some of the other methods, it is apparent that the efficiency of the weld is dependent upon the properties of this arc-fused metal. Hence a knowledge of its properties is of fundamental importance in the study of electric-arc welds.

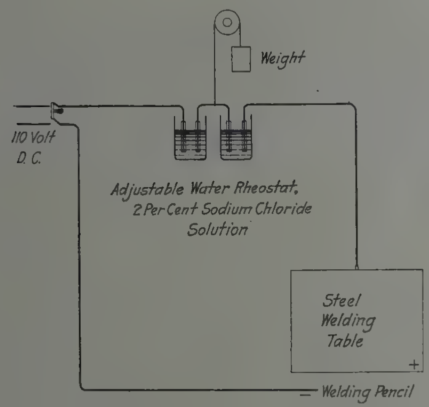
Weight
110 Volt D.C.
Adjustable Water Rheostat, 2 Per Cent Sodium Chloride Solution
Steel Welding Table
+
Welding Pencil

Fig. 1 Diagram of Apparatus Used in the Preparation of the Specimens of Arc-Fused Metal

Though the results available at present are not as conclusive throughout the entire series of examinations made as might be desired, it is believed that they contribute very materially to our knowledge of the properties of the fused-in metal which is ultimately the deciding factor as to the serviceability of the electric-arc weld. The investigation included a study of the composition changes which accompany the fusion of the metal, the determination of the mechanical properties of the arc-fused metal together with the examination of the structure of the metal after fusion, in the endeavor to explain the observed mechanical and chemical characteristics.

The specimens required for the study of the mechanical properties of the arc-fused iron were prepared for the most part at the Bureau of Standards, direct current being used in all the operations. The apparatus used is shown diagrammatically in Fig. 1. By the use of automatic recorders the voltage and current were measured and records were taken at intervals during the preparation of a specimen.

Since the investigation was concerned primarily with the properties of the arc-fused metal, regular welds were not made. Instead the metal was deposited in the form of blocks (Fig. 2), each one being large enough to permit a tension specimen (0.505 in. in diameter, 2 in. gage length) to be machined out of it. Although the opinion is held by some welders that the properties of the metal of an arc weld are affected materially by the adjacent metal by reason of the interpenetration of the two during fusion, it was decided that the change of properties of the added metal induced by fusion alone, was of fundamental importance and should form the basis of any study of arc welding. The method adopted also permitted the use of larger specimens with much less machining than would have been possible had the metal been deposited in the usual form of a weld. The block of arc-fused metal was built up on the end of a section of ½-in. plate of mild steel (ship plate). When a block of sufficient size had been built up, it, together with the portion of the steel plate immediately beneath, was sawed off from the remainder of the steel plate. The tension specimen was turned entirely out of the arc-fused metal. No difficulty whatever was experienced in machining the specimens.

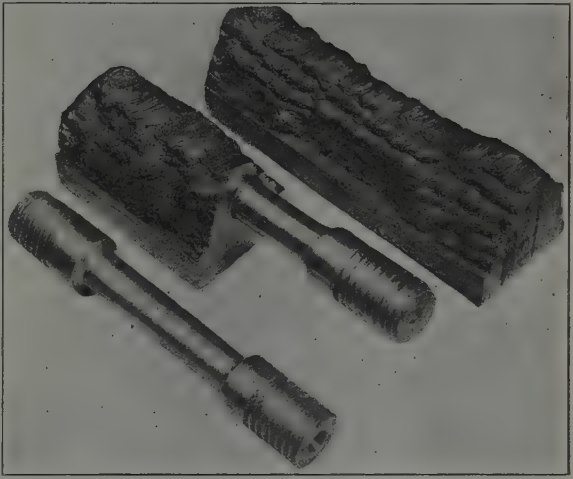

Fig. 2 Blocks of Arc-Fused Metal with Tension Specimen cut Therefrom

In general, in forming the blocks, the fused metal was deposited as a series of "beads," so arranged that they were parallel to the axis of the tension specimen which was cut later from the block. For purposes of comparison in a few specimens, the metal was deposited in beads at right angles to the length of the block. In all the specimens, after the deposition of each layer, the surface was very carefully and vigorously brushed with a stiff wire brush, to remove the layer of oxide and slag which formed during the fusion. There was found to be but little need to use the chisel for removing this layer.

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[1] Physicist, Bureau of Standards.

Tension specimens only were prepared from the arc-fused metal. It is quite generally recognized that the tension test falls very short in completely defining the mechanical properties of any metal; it is believed, however, that the behavior of this material when stressed in tension is so characteristic that its general behavior under other conditions of stress, particularly when subjected to the so-called dynamic tests, i. e., vibration and shock, can be safely predicted from the results obtained. In order to supplement the specimens made at the Bureau a series was also prepared by one of the large manufacturers of equipment for electric welding to be included in the investigation.

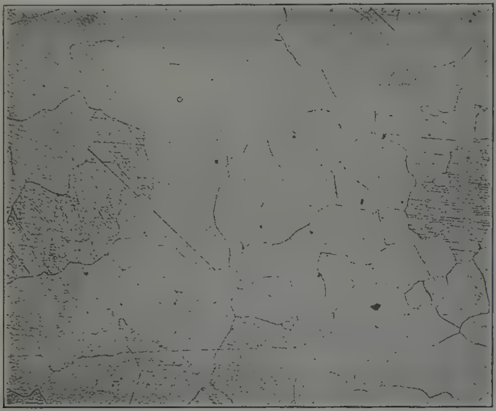

Fig. 3 Microstructure of "Pure-Iron" Type of Electrode Used (× 100)

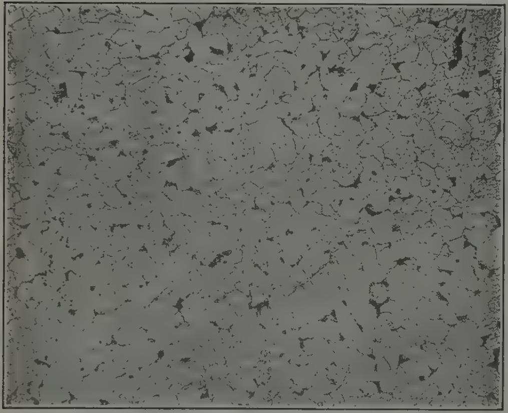

Fig. 4 Microstructure of Low-Carbon Steel Electrode Used (× 100)

Two types of electrodes were used as material to be fused. These differed considerably in composition and were chosen as representative of a "pure" iron and a low-carbon steel (see microstructures in Figs. 3 and 4), the approximate carbon content of the two being respectively 0.02 and 0.15 per cent. Each type was obtained in sizes ranging from ⅛ in. in diameter to ¼ in., so that a considerable range of current densities was possible. The electrodes were used both in the bare condition and after being slightly coated with a paste of an oxidizing and refractory nature, the purpose being to prevent excessive oxidation of the metal of the electrode during fusion and to form also a thin protective coating of slag upon the fused metal.

Changes in Composition of Electrodes as a Result of Fusion

In general, the effect of the fusion in the arc is to render the metal of two electrodes quite similar in composition. The data summarized in Table 1 are typical of the changes.

TABLE 1 PERCENTAGE COMPOSITIONS OF ELECTRODES BEFORE AND AFTER FUSION

Type	A		A		B	
Size, in.	⅛		3/16		⅛	
	Before	After	Before	After	Before	After
Carbon	0.058	0.031	0.022	0.010	0.15	0.024
Silicon	0.33	0.007	0.16	0.012	0.06	0.008
Manganese	0.042	tr.	0.038	tr.	0.47	tr
Phosphorus	0.002	0.005	0.002	0.002	0.018	0.002
Sulphur	0.057	0.036	0.040	0.033	0.021	0.035
Nitrogen[1]	0.0030	0.143	0.0040	0.126	0.0032	0.140

[1] Average of several determinations on different electrodes of same size and type.

The loss of carbon and of silicon is very marked in each case the nitrogen content of the metal. In general the increase was where these elements exist in considerable amounts. A similar tendency also exists for manganese.

The most noticeable change in composition is the increase in the nitrogen content of the metal. In general the increase was rather uniform for all specimens. In Fig. 5 the average nitrogen contents found for the different conditions of fusion are plotted against the corresponding current densities. Though no definite conclusion seems to be warranted, it may be said that, in general, the percentage of nitrogen taken up by the fused iron increases somewhat as the current density increases. With the lowest current densities used the amount of nitrogen was found to decrease appreciably. Other investigators in this line have reported an increase in nitrogen content under similar conditions.

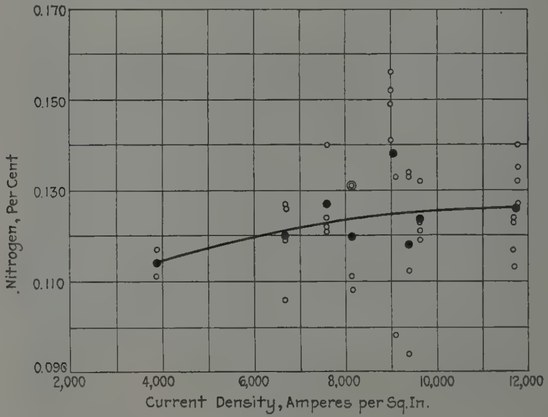

Fig. 5 Relation of the Nitrogen Content of the Arc-Fused Metal to the Current Density

Mechanical Properties of the Arc-Fused Metal

When it is considered that the metal which forms a fusion weld is essentially a casting, it is not surprising that there should be a very considerable difference between the mechanical properties of the metal in the form of electrodes or welding pencils and the same after fusion. The average tensile properties of the two types of electrodes are as given in Table 2.

TABLE 2 AVERAGE TENSILE PROPERTIES OF PURE-IRON (A) AND LOW-CARBON STEEL (B) ELECTRODES

Type of Electrode	Ultimate Strength, lb. per sq. in.	Proportional Limit, lb. per sq. in.	Elongation in 2 in., per cent	Reduction of Area, per cent.
A	61,000	40,000	14	68
B	86,000 67,000	63,000 37,000	6 15	55 61

The size of the electrode tested and the physical state of the metal, that is, the amount of cold working the metal received, cause rather wide variations in the properties. After fusion, however, the properties are very different, as shown in Table 3.

TABLE 3 TENSILE PROPERTIES AND HARDNESS OF ARC-FUSED METAL

Type of Electrode	Average Ultimate Strength, lb. per sq. in.	Average Yield Point, lb. per sq. in.	Elongation in 2 in., per cent	Reduction of Area per cent	Brinell Hardness	Shore Hardness
A (bare)[1].....	48,900	35,300	7.9	10.0	103	16.6
A (covered)[1].	46,600	34,600	8.5	9.0	103	16.6
B (bare)[1].....	48,800	34,200	8.5	10.5	103	16.0
B (covered)[1].	47,400	32,200	9.9	13.8	103	16.0
C[2]..........	49,900	32,700	11.0	17.6	113	17.0

[1] "Bare" electrodes were those which were used in the conditions as received "covered" ones were coated as mentioned in the text.

[2] These specimens were prepared by a large welding firm and submitted to the Bureau to be included in the series.

The variations for the specimens of any particular type of electrode are rather wide, usually within the limits of ± 6 per cent. No definite conclusions could be drawn concerning the merits of the various electrodes. All the specimens have properties similar to those of steel castings of a rather inferior grade; the variations noted are of the order which might be expected for such cast steel of inferior quality. There does not appear to be any material advantage so far as the properties of the metal obtained were concerned in coating the electrodes. The specimens which were prepared by different operators compare very favorably with each other. The most striking feature in the mechanical properties is the low ductility of the metal.

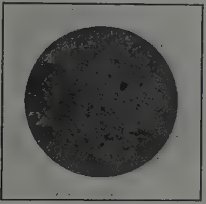

Fig. 6 Fractured End of a Tension Specimen After Test; Natural Size

Nearly all the specimens upon fracturing revealed a defect similar to the one shown above.

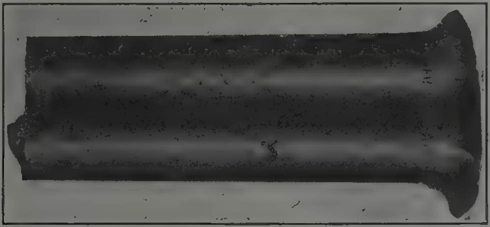

Fig. 7 Side View (natural size) of the Tension Specimen Shown in Fig. 6

The characteristic appearance of the specimens after testing, illustrating their behavior when stressed in tension until rupture occurs, is shown in Figs. 6 and 7. The features shown are quite typical of the set of specimens. The fracture in all cases revealed interior flaws and defects. Although the results of the tension test appeared to indicate a fair elongation, examination of the specimens showed that the measured elongation does not truly represent a property of the material, but is due rather to the interior defects which indicate lack of perfect union of succeeding additions of metal during the process of fusion. The surface features of the specimens after stressing are very similar to those seen in the type of defective steel familiarly known as "flaky," which was a source of much discussion and delay of production during the progress of the war.

As previously noted, specimens were prepared for the purpose of showing the relation between the direction in which the stress is applied and the manner of deposition of the metal. The metal was deposited so that the beads of fused metal extended across the piece rather than lengthwise, hence the beads were at right angles to the direction in which the tensional stress was applied. The results of the tension tests are given in Table 4 and show that these two specimens (1 and 2) were decidedly inferior to those prepared in the other manner.

Structural Features

The general condition of the metal resulting from the arc fusion is shown in Figs. 8 and 9, which represent longitudinal sections of tension specimens. The metal in all of these specimens was found to contain a considerable number of cavities and oxide inclusions, these are best seen after the polished surfaces are etched with a 10 per cent aqueous solution of copper-ammonium chloride. In many of the specimens the successive additions of metal are outlined by a series of very fine inclusions (probably oxide) which are revealed by the etching. There appears to be no definite relation between the soundness of the metal and the conditions of deposition, i. e., for the range of current density used; nor does either type of electrode used show any decided superiority over the other with respect to porosity of the resulting fusion. The condition of the material prepared by experienced "practical" welders is quite similar to that prepared by the Bureau.

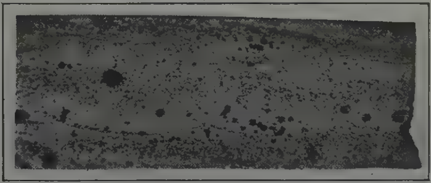

Fig. 8 Longitudinal Section of a Tension Specimen of Arc-Fused Metal

Natural size; polished and etched with copper-ammonium chloride solution to accentuate internal defects.

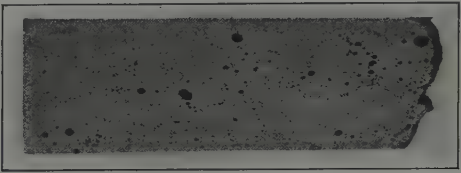

Fig. 9 Longitudinal Section of a Tension Specimen of Arc-Fused Metal

Natural size; polished and etched with copper-ammonium chloride solution to accentuate internal defects.

TABLE 4 TENSILE PROPERTIES OF THE SPECIMENS TESTED

Specimen	Ultimate Strength, lb. per sq. in.	Proportional Limit, lb. per sq. in.	Elongation in 2 in., per cent	Reduction of Area, per cent
1	40,450	22,500	6.5	8.5
2	39,500	22,500	4.0	3.0

It is to be expected that the microstructure of the material after fusion will be very considerably changed, since the metal is then essentially the same as a casting. It has some features, however, which are not to be found in steel as ordinarily cast. The general type of microstructure was found to vary in the different specimens and to range from a condition which will be designated as "columnar" to that of a uniform fine equi-axed crystalline arrangement. This observation held true for both types of electrodes, whether bare or covered. In the examination of cross-sections of the blocks of arc-fused metal it was noticed that the equi-axed type of structure is prevalent throughout the interior of the piece and the columnar is to be found generally nearer the surface, i. e., in the metal deposited last. It may be inferred from this that the metal of the layers which were deposited during the early part of the preparation of the specimen is refined considerably as to grain size by the successive heatings to which it is subjected as additional layers of molten metal are deposited. The general type of structure of the tension bars cut from the blocks of arc-fused metal will vary considerably according to the amount of refining which has taken place as well as the relative position of the tension specimen within the block. In addition it was noticed that the columnar and coarse equi-axed crystalline condition appears to predominate with fusion at high current densities.

In all of the specimens of arc-fused metal examined microscopically there were found numerous tiny globules of oxide as shown in Fig. 11. In general they appear to have no definite arrangement but occur indiscriminately throughout the crystals of iron.

A type of unsoundness frequently found is that shown in Fig. 10, which will be referred to as "metallic globule inclusions." In general these globules possess a microstructure similar to that of the surrounding metal but are enveloped by a film, presumably of oxide. It seems probable that they are small metallic particles which were formed as a sort of spray at the tip of the electrode and which were deposited on the solidified crust surrounding the pool of molten metal directly under the arc. These solidified particles apparently are not fused in with the metal which is subsequently deposited over them, i. e., during the formation of this same layer and before any brushing of the surface occurs.

The most characteristic structural feature of the metal after fusion is the presence of numerous needles or plates within the ferrite crystals. The general appearance of this feature is shown in Fig. 11. The number and distribution of these needles were found to vary greatly in different specimens; in general, however, they are most abundant in the columnar and in the coarse equi-axed crystals. Their distribution within the individual crystals indicates that they are arranged along the crystallographic planes.

The usual explanation of these plates is that they are due to the nitrogen which is taken up during the fusion. Other suggestions offered by different investigators at various times are to the effect that they are due to oxide and to carbide. While it is not to be denied that the oxide content increases to a very pronounced exent—as is evident from the microscopic examination of any specimen of weld metal whatever, the characteristic appearance of such oxide inclusions, as well as their behavior when the specimen is heated for long periods (e.g., 6 hours at 1000 deg. cent. was used in some of the experiments) makes the suggestion that oxide forms the substance of such plates or needles seem very improbable. Likewise the suggestion of carbide may also be dismissed. The tendency during fusion is for the carbon to be "burnt out" of the metal and only a small amount remains. In practically all of the specimens enough carbide (as pearlite) may be found to account for the carbon content of the metal as revealed by the chemical analysis. The fact that the nitrogen

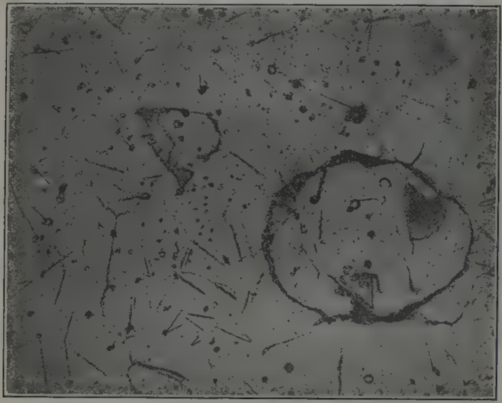

FIG. 10 MICROSCOPIC EVIDENCE OF UNSOUNDNESS
The globule at the right is surrounded by a film of oxide, and the fracture of specimens when tested in tension originates in such unsound areas.

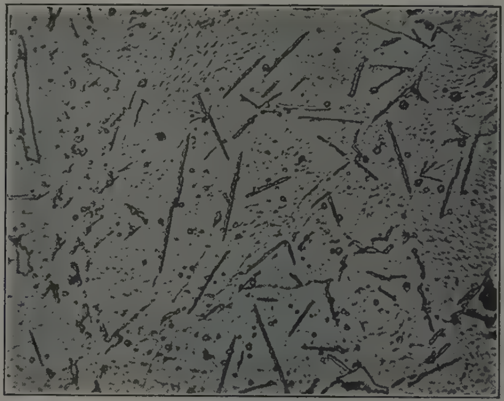

FIG. 11 CHARACTERISTIC FEATURE OF ARC-FUSED IRON
The "needles" or "plates" are due to the increase which occurs in the nitrogen-content during fusion. (× 500)

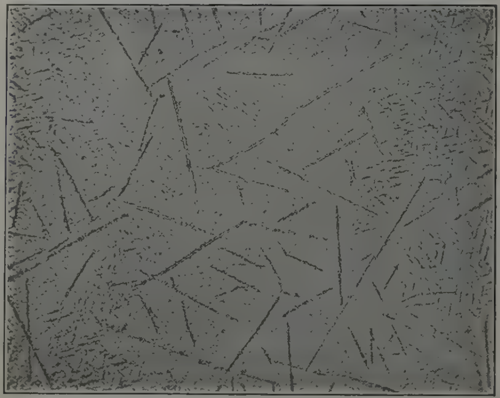

FIG. 12 NITROGENIZED IRON, SHOWING CHANGE IN STRUCTURE CAUSED BY HEATING IN AMMONIA
Electrolytic iron was nitrogenized by heating it for several hours (approx. 650 deg. cent.) in ammonia. The change in structure is due to the nitrogen which is taken up. Compare with Fig. 11. (× 500)

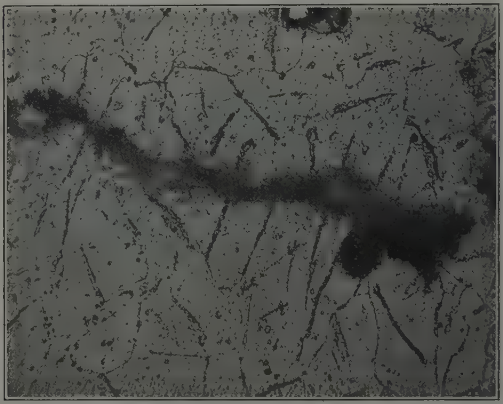

FIG. 13 RELATION OF PATH OF RUPTURE TO THE MICROSTRUCRURE OF ARC-FUSED IRON
The course of the crack or tear in the metal which was produced by stressing in tension does not appear to have been influenced appreciably by the "nitride plates." (× 500)

content increases during fusion and also that iron which has been nitrogenized under known conditions has a structure practically identical with that of the arc-fused metal, is very strong evidence in favor of the view that the nitrogen is responsible. See Fig. 12. When once combined with the iron the nitrogen is eliminated only with great difficulty. A heating of six hours in vacuo at 1000 deg. cent. (1830 deg. fahr.) reduced the nitrogen by about only 50 per cent of its initial value.

The pronounced effect of the nitrogen which is gained by the metal during fusion upon the thermal characteristics of the iron in the partial suppression and lowering of the transformation changes is shown in Fig. 14. The suggestion that such a pronounced change in the structure of the metal should have a similar pronounced effect upon the mechanical properties of the metal is a reasonable one. Numerous microscopic examinations were made with the aim of demonstrating to what extent the properties are affected, particularly whether these plates determine to any pronounced extent the course of the fracture of the specimen when broken in tension. It appears, however, as shown in Fig. 13, that the path of rupture is not affected appreciably by these so-called "nitride-plates." The effect of the grosser imperfections of the metal, i. e., oxide inclusions and films, "metallic globule" inclusions, and lack of adhesion between successive layers of the weld metal, is so much greater than any possible effect of the nitride plates in determining the mechanical properties of the specimen as a whole that the conclusion appears to be warranted that this feature of the structure is a matter of relatively minor importance in ordinary arc welds.

In arc-fusion welds in general the mass of weld metal is in intimate contact with the parts which are being welded, so that it is claimed by many that because of the diffusion and intermingling of the metal under repair with that of the electrodes the properties of the latter are considerably improved. The comparison shown in Table 5 somewhat supports this claim. The nearest comparison found available with the Bureau's specimens are some of those of the welds designated as the "Wirt-Jones" series reported by H. M. Hobart of the Research Committee of the American Welding Society. The welds were of the 45-deg. double-V type made in ½-in. ship plate; the specimens for test were of uniform cross-section, 1 in. by ½ in., the projecting metal at the joint having been planed off even with the surface of the plates, and the test bars were so taken that the weld extended transversely across the specimen near the center of its length. The electrodes used were similar to those designated as type B in the Bureau's investigation.

In any consideration of electric-arc welding it should be constantly borne in mind that the weld metal is simply metal which has been melted and has then solidified *in situ*. The weld is essentially a casting, though the conditions for its production are very different from those ordinarily employed in the making of steel castings. The metal loses many of the properties it possesses when in the wrought form, and hence it is not to be expected that a fusion weld made by any process whatever will have all the properties that metal of the same composition would have when in the forged or rolled condition. A knowledge of the characteristic properties of the arc-fused iron is then of fundamental importance in the study of the electric-arc weld.

TABLE 5 COMPARISON OF BUREAU OF STANDARDS AND WIRT-JONES TESTS

Bureau of Standards Tests			Wirt-Jones Tests		
Electrode	Ultimate Strength, lb. per sq. in.	Elongation in 2 in., per cent	Electrode	Ultimate Strength, lb. per sq. in.	Elongation in 2 in., per cent
⅛ in.	48,700	8.0	⅛ in.	54,900	10.0
$\frac{5}{32}$ in.	48,600	10.0	$\frac{5}{32}$ in.	59,800	9.0

The peculiar conditions under which the fusion took place also render the weld metal quite different from similar metal melted and cast in the usual manner. It is seemingly impossible to fuse the metal without serious imperfections. The mechanical properties of the arc-fused metal are therefore dependent to an astonishing degree upon the skill, care, and patience of the welding operator. The very low ductility shown by specimens when stressed in tension is the most striking feature observed in the mechanical properties of the material as revealed by the tension test. As explained above, the measured elongation of the tension specimen does not truly indicate a property of the metal. Due to the unsoundness already referred to in the discussion of the structure, the true properties of the metal are not revealed by the tension test to any extent. The test measures, largely for each particular specimen, the adhesion between the successively added layers, which value varies considerably in different specimens due to the unsoundness caused by imperfect fusion, oxide and other inclusions, tiny enclosed cavities and similar undesirable features. The elongation measured for any particular specimen is due largely, if not entirely, to the increase of length resulting from the combined effect of the numerous tiny imperfections which exist throughout the sample.

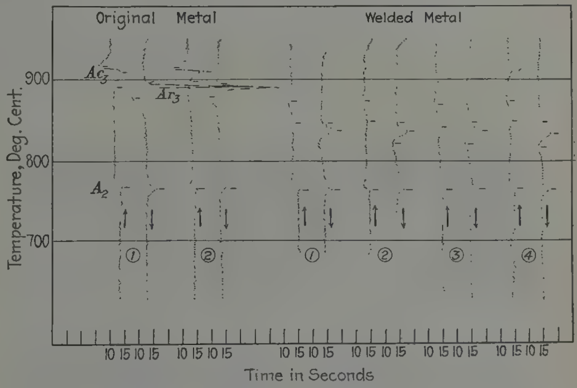

FIG. 14 EFFECT OF ARC FUSION UPON THE THERMAL CHARACTERISTICS OF LOW-CARBON STEEL

The metal originally contained 0.02 per cent carbon; after fusion the composition is very similar except that it has taken up nitrogen to the extent of 0.13 per cent.

That the metal is inherently ductile, however, is shown by the behavior upon bending as recorded in the microstructure of the bent specimen. The formation of slip bands within the ferrite grains to a very marked extent occurs under such conditions and is evidence of a high degree of ductility. It appears, however, that the grosser imperfections are sufficient to prevent any accurate measurement of the real mechanical properties of the metal from being made. The conclusion appears to be warranted, therefore, that the changes of composition which the fusion entails, together with the unusual features of microstructure which accompany the composition change, are of minor importance in determining the strength, durability, and other properties of the arc weld.

Since the specimens used in the work described were prepared in a manner quite different from the usual practice of arc welding, no definite recommendations applicable to the latter can be based upon the results. It appears, however, from the results obtained that the two types of electrodes used, i. e., "pure" iron and low-carbon steel, should give very similar results in practical welding. This is due to the changes which occur during the melting, so that the resulting fusions are essentially of the same composition. In fact, the most valuable conclusion which the results of the study warrant is that an arc weld is essentially a casting the properties of which are determined to a very large extent by the skill, ingenuity, and experience of the operator. If this essential characteristic of arc welds is borne in mind, the method will not be used in places where it is evident from the conditions of stresses existing in service that a casting should not be used, and it will also determine in innumerable cases that arc welding is the most efficient method to be considered.

METALLIC-ELECTRODE ARC-WELDING PROCESS

By O. H. ESCHHOLZ,[1] EAST PITTSBURGH, PA.

THE metallic-electrode arc-welding process is essentially a method for casting mild steel on a properly fused surface. Upon drawing an arc between a wire electrode and a metal surface, electrical energy is converted into thermal energy which serves to fuse the metal at both terminals. When a short arc length, 1/8 in. or less, is maintained, molten filler electrode metal is conveyed automatically to a fused surface.

The basic phenomena in fusion welding are those affecting metal transition. Upon drawing an arc with bare electrodes in downward welding, a pool of molten metal is formed at the positive or plate terminal and a liquid globule at the end of the negative terminal. This globule enlarges, with the continued application of energy, until the retaining forces, surface tension and cohesion, are exceeded by the globular weight, when the metal drops to the plate. Upon holding a short arc, globule growth is limited by contact with the fused plate surface, and the forces of surface tension and adhesion at the contact area then assist the force of gravity in removing the molten globule.

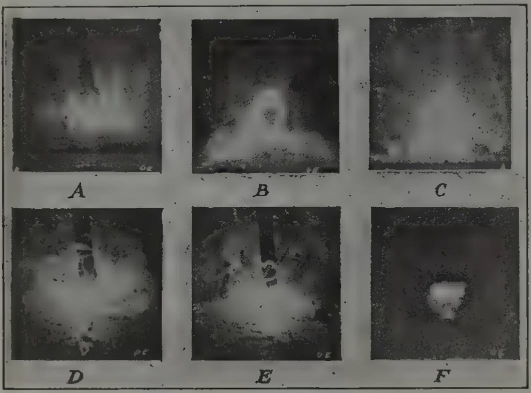

Fig. 1 Metal Deposition

a, b, c, illustrate growth, release and deposition of liquid globule; *d* and *e* show electrode before and after deposition; *f* shows the appearance of electrode end immediately after interrupting arc.

It is evident that with a given electrode the rate of metal deposition may be increased, within limits, upon shortening the arc length. Electrodes differ in the speed and size of globule formation. The deposition rate has been observed to vary from two to sixty globules a second and the globule diameter from 1-32 in. to 5-32 in., depending upon the energy density, electrode analysis, preparation and arc length. The appearance of the negative or globular electrode terminal is indicative of its constituents and process of manufacture.

In Fig. 1 are shown high-speed photographs of the arc stream and terminals during metal transition. In this figure, *a, b* and *c* illustrate, respectively, the growth, release and deposition of metal under the exaggerated condition of maintaining a long arc with a large globule-forming electrode of high carbon content; *d* and *e* show respectively the appearance of the arc and a low-carbon steel electrode immediately before and after metal deposition; and *f* gives a view of the globular terminal immediately after interrupting the arc.

The sequence of circuit phenomena[2] accompanying metal deposition is shown graphically in Fig. 2. The initial rush of current at electrode contact serves to accelerate metal fusion. In the succeeding interval, globular growth occurs until contact is made with the plate, short-circuiting the arc. This causes a drop in arc voltage but an increase in current, the added energy obtained in the contact resistance tending to replace the energy developed at the arc terminal and thereby maintain the metal in a fused state.

Physical Properties of Arc-Deposited Metal

Although this subject would appear to be of primary importance in the design and execution of welded structures, very few data are available concerning it. The refining[3] action of the atmospheric gases on the transferred metal is now, however, recognized.

The following analyses are typical of metal deposited from *bare* wire electrodes:

	C	Mn	P	S	Si
Electrode	0.16	0.56	0.032	0.024	0.016
Deposited Metal	0.05	0.18	0.031	0.036	0.011
Electrode	0.049	0.021	0.025	0.007	0.08
Deposited Metal	0.05	0.018	0.020	0.015	0.011

The variation in analysis of the conveyed metal is determined by the degree of exposure to oxidation. Upon holding a short arc length and employing special impregnated, covered or coated electrodes, which develop an arc-enveloping screen of inert gases, the analysis of deposited metal will approximate that of the filler electrode.

To determine the physical properties of *arc-deposited metal* test coupons were taken, respectively, from 7-lb. and 14-lb. deposits. In forming these the welder employed a short arc length, an arc current of 175 amperes and a 5-32 in. diameter low-carbon steel bare electrode. The metal was deposited in layers, each succeeding tier being at right angles. The surface of each tier in the 7-lb. deposit was sand-blasted, while in the 14-lb. deposit it was cleaned with a wire brush, which is the practice usually followed.

TABLE 1 RESULTS OF TENSILE TESTS ON MATERIAL IN 7-LB. DEPOSIT OF ARC METAL

Test No.	U. T. S.	Yield Pt.	Elas. Limit[1]	Per cent Elon. in 2 in.	Per cent Reduction
	Lb. per sq. in.				
77674-1	56,075	35,875	29,000	16	23.4
77674-2	58,225	.....	.....	18	27.8

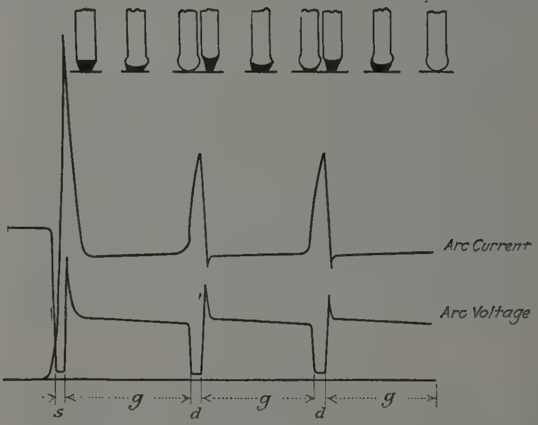

Fig. 2 Sequence of Arc Phenomena

s, start of arc; *g*, growth of liquid globule; *d*, deposition of metal.

The fractures displayed the typical structure of a high-grade, partially annealed, low-carbon cast steel. These values exceed those obtainable from metal deposited by the average welder, and may be used as a "bogie" in the development of both welders and electrodes.

The results of tests on the 14-lb. deposit, formed under conditions analogous to those obtaining on welding a locomotive frame, are given in Table 2.

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[1] Research Engineer, Westinghouse Electric and Manufacturing Company.

[2] Metal Deposition in Metallic Electrode Arc Welding, by O. H. Eschholz, *Electrical World*, June 26, 1920, and July 17, 1920.

[3] Some Recent Investigations in Arc Welding, by O. H. Eschholz, Proc. A. I. & S. E. E., December, 1917.

TABLE 2 RESULTS OF TENSILE TESTS ON MATERIAL IN 14-LB. DEPOSIT OF ARC METAL

Tensile Test No.	U. T. S.	Yield Pt.	Elas. Limit[1]	Per cent Elon. in 2 in.	Per cent Reduction
	Lb. per sq. in.				
77,651-1	58,825	41,000	40,000	8.2	19.9
77,651-2	54,650	35,000	29,000	6.5	13.4

Compression Test No.	Elas. Limit,[1] Lb. per sq. in.
77651-1A	29,450
77651-2A	34,500

Brinell Hardness, No. 114.

Transverse: Ultimate, 89,400 lb. per sq. in.; elas. limit,[1] 47,600 lb. per sq. in.; supports, 6 in.; deflection, 0.03 in.

Cantilever: Ultimate, 86,200 lb. per sq. in.; elas. limit,[1] 44,750 lb. per sq. in.; supports, 2 in.; deflection, 0.03 in.

Bending: 100 deg. on 1 in. radius, bar ½ in. thick.

Shear: 46,200 and 44,600 lb. per sq. in.

Impact: Izod, unannealed specimens, 2; 2; 1; ft.-lb.

[1] Elastic limits were obtained by Johnson's method.

These data are typical of the characteristics of arc metal when deposited by a conscientious, skilled welder. Similar results will be consistently obtained only when mechanical engineers demand proper instruction and supervision of welding operators. Further improvement in metal characteristics may be secured by the use of special electrodes and heat treatment.

Physical Properties of Arc-Welded Sections

A weld is formed by the fusion of successive layers of deposited metal. The appearance of the section through a single layer fused to a plate surface is shown in Fig. 3, the characteristic contour, penetration and overlap of which may be noted.[4] On welding sections scarfed to a vee opening it is necessary to separate the shank members by a "free distance" of 1-16 in. to ⅛ in. This separation facilitates the fusion of the initial deposited layer to both members, the most important step in fusion welding. In Fig 4, *A* and *B* show respectively sections through plate and deposited metal welded with and without the use of a free distance. In Fig. 4 at *A* fusion is indicated by the irregular line of recession from the original scarfed surface; in the same figure at *B* fusion is shown present only at the top of the joint. The clearance between sections, at the apex of the vee, in this weld, was not sufficient to permit arc formation.

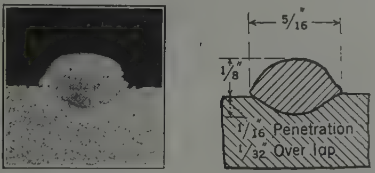

Fig. 3 Typical Section Through a Layer of Electrode Metal Deposited on a Low-Carbon Steel Plate When Using a Short Arc, 150 Amperes and 5/32-in. Bare Electrode

Note penetration, small overlap at deposit edges, and extent of structural change caused by thermal disturbance.

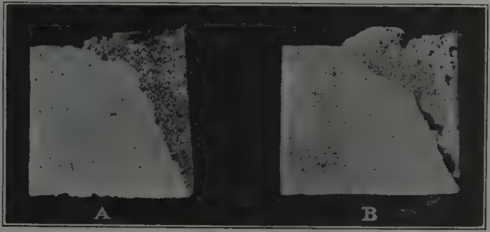

Fig. 4 Sections Midway Through Weld Showing Shank Metal, Arc-Deposited Metal and Character of Fusion with and without the Use of a "Free Distance" at Vee Apex

The total thermal energy developed at the fused zones is determined by the arc current employed. It is evident, therefore, that the arc current must be changed with variation in the thermal capacity, thermal conductivity, and temperature of the weld.[5] In Figs. 5, *A* and *B* show sections through welds made with arc currents of 150 and 100 amperes respectively. Fig. 5*A* shows a fracture at a stress approximately 95 per cent of the U. T. S. of the shank metal, while Fig. 5*B* shows a break which occurred during machining. Difference in fusion at scarfed surface and in deposit, homogeneity of metal and character of fracture are marked. Fig. 6 summarizes the results of many tests and indicates the variation in weld strength with arc current for skilled and average welders. Fig. 7 gives suggested current values to be used for various plate thicknesses and electrode diameters. It must be recognized, however, that the position of the plate and any unusual condition affecting thermal factors require other current values.

The data in Table 3 have been selected from tests made by the Bureau of Standards on properly executed bare-electrode arc welds prepared for the Welding Committee of the Emergency Fleet Corporation.[6]

TABLE 3 MACHINED, WELDED SHIP PLATES

Test No.	U. T. S.	Yield Pt.	Elon. in 2 in.	Bending 1.5 in. diam. Deg.	Vibration.[1]
	Lb. per sq. in.				
Original	64,700	38,400	31.5	180	143,753
1	59,800	35,400	9.0	42	845.892
2	62,600	39,000	11.5	44	316,825
5	61,100	35,650	8.5	55	87,762
7	57,600	39,000	8.5	50	41,376

[1] Inconclusive. Fiber stress, 25,000 lb. per sq. in.; r.p.m. = 120; tests made on Upton-Lewis machine.

The characteristic average data shown in Tables 4 and 5 were obtained from tests made for Lloyd's Register of Shipping by David Kirkaldy and Sons, London, on ship plates welded with covered electrodes.

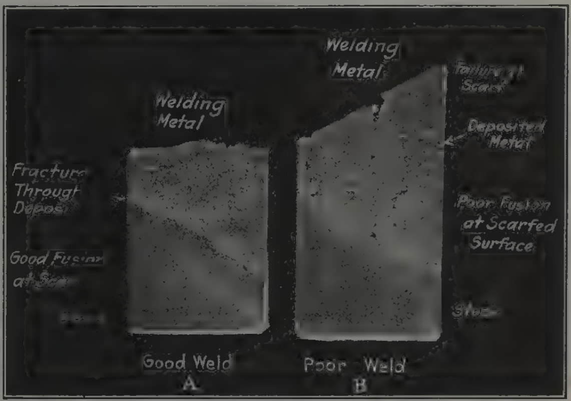

Fig. 5 Appearance of Weld Sections When Using (*A*) 150 Amperes Arc Current and (*B*) 100 Amperes

TABLE 4 TESTS ON SHIP PLATES WELDED WITH COVERED ELECTRODES

Specimen.	U. T. S.	Yield Pt.	Per cent Elong. in 8 in.	Reduction, per cent	No. of Tests
	Lb. per sq. in.				
Unwelded	62,000	.....	28	45	4
Welded plate	60,400	.....	18	35	8
Arc deposited metal	64,500	44,600	13	21	2

TABLE 5 ALTERNATING-STRESS TEST, 1000 R.P.M., ROTATING WELDED BAR ⅝-IN. DIAMETER

Specimen.	Stress at Periphery. Lb. per sq. in.	Rotations.	Remarks.
Unwelded	±23,500	5,000,000	Fractured
Welded	±14,000	4,355,000	Fractured
Welded	±14,000	5,000,000	Unbroken
Welded	±18,800	5,000,000	Unbroken
Welded	±18,800	1,705,000	Fractured
Welded	±20,500	1,510,000	Fractured

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[4] A complete discussion of fusion characteristics is contained in a paper by the author on Fusion in Arc Welding, Proc. A. I. E. E., March 1919.

[5] Training of Arc Welders, O. H. Eschholz, *Electrical World*, September 27, 1919, October 4, 1919.

[6] Welding Mild Steel, H. M. Hobart, Proc. A. I. E. E., March, 1919.

While the data in these tables may be typical now of a skilled welder only, nevertheless they indicate the potentialities of the process and the progress to be obtained in welded structures by the development of proficient operators.

Conclusions

The present status of arc welding may be summarized as follows:

a Mainly utilized for the welding of low-carbon steel members subjected to static tension or compression stresses

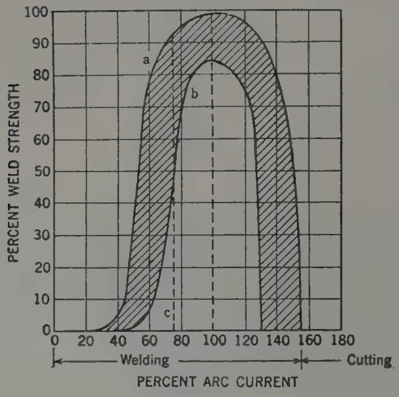

Fig. 6 Approximate Change in Weld Strength with Change in Arc Current for (*A*) Skilled and (*B*) Average Welders

Welders tend, as a rule, to employ a current value approximately equal to 75 per cent, that giving best results. The weld strength, as shown by *c*, will therefore vary from 40 per cent to 90 per cent of maximum, depending on the skill of the operators.

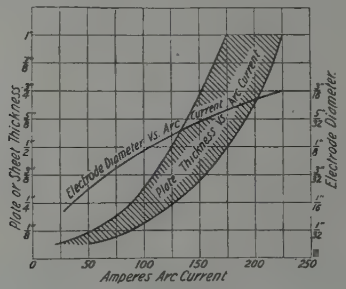

Fig. 7 Relation of Approximate Arc Currents and Electrode Diameters

b Production and repair welding of parts wherein possible weld failure will not involve life hazard

c Knowledge of welding phenomena and correct welding procedure is not widely disseminated

d Process control and inspection methods, although practicable, are not enforced.

The trend of future activity appears to be as follows:

a Initiation of training schools having a standardized welding course, in large industrial establishments

b Uniform electrode specifications and tests

c Further determination of physical properties of arc-deposited metal with a resulting continued development in electrode manufacture and process control

d Application of inspection methods

e Introduction of automatic arc welding

f Application to non-ferrous metal welding

g Definition of the limitations of the process in the welding of the various alloys, steels and structures subjected to fatigue stresses.

New York Law Requires Licensing of Engineers

The New York Law for the licensing of professional engineers and land surveyors became effective May 14, 1920. Its administration is in the hands of a board of five licensed engineers appointed by the regents of the University of the State of New York. The personnel of this board has not as yet been named, although it is expected that the appointments will be made on or before October 8. A brief abstract of the law prepared by Engineering Council follows:[1]

Application For Certificate. Must be made on prescribed form to Regents of the University of the State of New York, Albany, New York. Present practitioners must obtain licenses within two years.

Professional Requirements. Law covers all those practicing or offering to practice professional engineering or land surveying.

Experience Without Degree. To practice Engineering—Six or more years of active professional engineering work, one of which shall have been in responsible charge, of a character satisfactory to the board. To practice Land Surveying—Four or more years of active engagement in land surveying work of a character satisfactory to the board.

Educational Allowance. Each two years of study of engineering in a school of engineering of standing satisfactory to the regents considered as equivalent to one year of active practice.

Society Membership. No provision covering membership.

General Requirements. *Citizenship of United States.* To practice Engineering—not necessary. To practice Land Surveying—necessary—or a declaration to become a citizen.

Age. At least 21 years.

Miscellaneous. Must be of good character and repute. To practice Land Surveying, must speak and write the English language.

Examinations. *Conditions Under Which Required.* If evidence presented in application does not appear to board conclusive or warranting issuance of a certificate, applicant may present further evidence, which may include the result of a required examination. Nature and frequency of examinations not prescribed.

Fees. For certificate to practice Engineering or Land Surveying—$25. For certificate to practice both Engineering and Land Surveying—$35. For reissuance of lost or destroyed certificate—$1. If issuance of certificate be denied, fee shall be returned.

Public Work. Two years after act takes effect, no county, city, town or village, or other political subdivision shall engage in construction or maintenance of any public work involving professional engineering or land surveying for which plans, specifications and estimates have not been made by, and construction and maintenance supervised by, a licensed engineer or land surveyor, provided contemplated expenditure for completed project does not exceed $2000.

Seals. Each licensee may obtain a seal of design authorized by board, bearing licensee's name and the legend "licensed professional engineer" or "licensed land surveyor." Plans, specifications, plats, and reports may be stamped with said seal.

Exemptions. *Employees of Licensed Practitioners.* Employees of licensed engineers or licensed land surveyors, so long as practice does not include responsible charge of design or supervision as principal.

Contractors and Superintendents. Not covered by this law.

Federal, State, and Municipal Employees. Employees of state or any political subdivision are exempted from the time act becomes effective only until the then existing term of office expires. Officers or employees of United States entirely exempt.

Corporations or Partnerships may engage in the practice of engineering or land surveying provided person or persons connected with such corporation or partnership in charge of design or supervision which constitutes such practice is or are licensed. Same exemptions as apply to individuals apply to corporations and partnerships.

Overlapping Duties. Engineers not prohibited from making land surveys essential to engineering projects.

Reciprocity. *Non-Resident Practitioner* may practice in this state, provided he is legally qualified for such professional service in his own state or country, where the necessary qualifications for which meet the requirements of the board of regents. May be granted a certificate upon payment of the required fee if he holds a like unexpired certificate from another state or territory in the United States in which the requirements for license or registration are of a standard satisfactory to the board.

New Resident. Provided he has filed application for license and has paid required fee, may practice for such reasonable time as the board requires in which to consider and grant or deny application.

Revocation of Certificate. The regents may revoke a certificate for cause only after a hearing at which the accused has the right to be represented by counsel, to introduce evidence and to examine and cross-examine witnesses.

Legislative Information. Law is Article IV-A of Chapter 25, Laws of 1909. Approved May 14, 1920. Introduced in Senate, No. 1104, by Mr. Ferris, March 17, 1920. Article VII-A, Chapter 25, Laws 1909 applies to registration of architects. Laws of 1915, Chapter 454.

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[1] Engineering Council does not guarantee the legal accuracy of this abstract.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

SUBJECTS OF THIS MONTH'S ABSTRACTS

COTTON ROPE FOR POWER TRANSMISSION
HORSEPOWER TABLE FOR POWER TRANSMITTED BY COTTON ROPE
SHEAR STRENGTH OF PLYWOOD WEBS
GEARED TURBINES WITH DOUBLE REDUCTION GEARS
TURBINES ON S.S. *Corrientes*
ALULA WING
DROP-FORGING DEFECTS
STEEL CASTINGS, LIGHT
CORE MAKING FOR STEEL CASTINGS
FUEL FOR ELECTRIC RAILWAYS
SAWMILL REFUSE AS FUEL
HARDENING CARBON STEEL AND RATE OF COOLING
AIR CLASSIFICATION OF PULVERIZED MATERIALS
RAYMOND SYSTEM OF AIR CLASSIFICATION
ZEITLIN VARIABLE-STROKE ENGINE
AIR-COOLED SLEEVE-VALVE ENGINE
BURT SINGLE-SLEEVE VALVE
LAWS OF HIGH-SPEED PUNCHING
ARMOR-PLATE PENETRATION BY PROJECTILES
STAMPS FOR HOT STAMPING
BRITISH AND AMERICAN PRACTICE IN STAMPING COMPARED
TWIST DRILLS, USE AND ABUSE
MORETTI HYDRAULIC TURBINE LATHE
LATHE FOR CRIPPLES, HYDRAULIC
BOWDEN PETROMETER
LANCHESTER CHASSIS AND ENGINE
WATER SOFTENING IN PITTSBURGH

Cotton Rope for Power Transmission

COTTON ROPE FOR TRANSMISSION, J. Melville Alison. General discussion of the subject based primarily on English practice, together with data of practical character on the installation and operation if such transmission.

From the article it would appear that cotton has entirely supplanted manila for transmission work in England, the reason for this being the longevity and high factor of efficiency of cotton rope. In fact, the author cites a case where ropes installed in October, 1879, and doing a 24-hour day's work are still in service. This is claimed to be sufficient to overcome the handicap of the higher initial cost of cotton rope. As regards the type of rope, 3- and 4-strand ropes are the most usual. The general advantage seems to lie with the 3-strand rope, because, as shown in Fig. 1, an equilateral triangle is obtained by connecting the centers of the strands, demonstrating the triangulation of the strains, which is a principle adopted by engineers in erecting angular constructions such as bridges. With the 4-strand rope and the same method of connecting the strand centers, a square is obtained, which is a less desirable structure. Furthermore, the 4-strand rope cannot be constructed without a supporting core and its collapse must mean the dislocation of the whole structure. The core, however, represents only about 1/40 of the cross-sectional area of the rope, and it must be reasonably assumed that the stresses exerted by the alternate contraction and extension of the spiral as the rope passes over the sheaves must tend toward the breaking up of this core, which actually takes place.

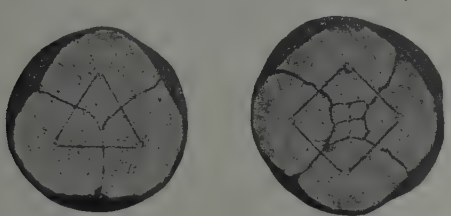


FIG. 1 SECTIONS OF 3- AND 4-STRAND COTTON ROPE

The relative spiral elongation of the two types of ropes is also such as to favor the 3-strand type.

Grooving. In laying out a groove it should be borne in mind that a rope is to all intents and purposes an elastic wedge and reaches its highest driving capacity when it is pressed to the shape of the groove itself. If the sides of the groove are merely tangent to the circle representing a given size of rope, there is a danger of the groove being too shallow, so that when the compression takes place (possibly after a short term of running) the rope is liable to find its way to the bottom of the groove. In this case slipping takes place, the true indication of which is heated sheave rims. Grooves with curved sides are undesirable.

The rope should decide the angle of the groove and not vice-versa. The groove may be set out as shown in Fig. 2.

First set a circle of equal diameter to the rope, draw the vertical and horizontal center lines. The chord of the arc *AB* is then marked off. This becomes the unit measurement and when laid off downward along the vertical line from the center of the circle, indicates the center of the curve of the bottom of the groove. Laid off a second time from this center, the apex of the inverted angle of the groove is determined. This angle always comes out at about 40 deg. whatever the size of the rope may be. Extend the lines of the angle through *BB*, cutting off segment of the circle on the way, until they intersect the horizontal dotted line through *A*, which points fix the radii of the mid-flanges. This groove may be taken as a standard for ropes over 1 in. in diameter and also shows the approximate actual compression which takes place in a rope at work.

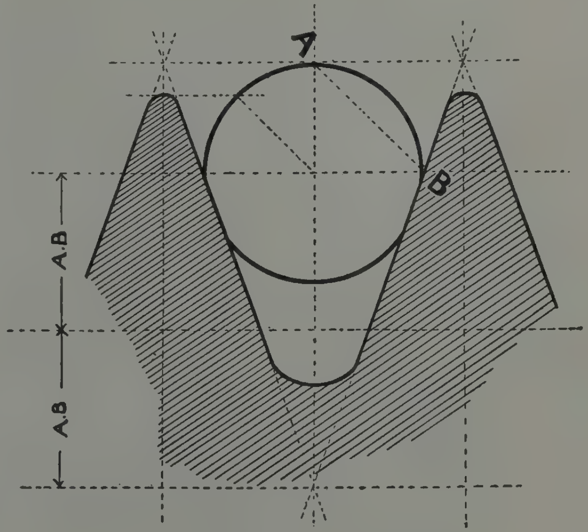


FIG. 2 GROOVING OF COTTON ROPE

Fixed and Revolving Ropes. The author is in favor of wedged rope, which with its angular formation makes a better groove contact than the revolving rope. Further, it has less tendency to slippage and a shorter life. Ropes which are underworked will often tend to revolve, a golden rule in rope transmission being that ropes like work to do.

TABLE 1 POWER TRANSMITTED BY VARIOUS ROPES AT VARIOUS SPEEDS

Velocity, ft. per min.	Diameter of Ropes, In.												
	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2
1000	4	6	9	12	15	19	24	28	34	39	46	53	60
2000	4½	7	10½	14	18	23	28	31	37	43	51	58	67
3000	5½	8½	12½	17	22	28	32	36	40	48	56	65	75
4000	...	...	14½	20	26	32	36	40	46	54	64	73	84
5000	...	...	...	23	30	38	43	48	55	64	75	87	98
6000	...	...	...	...	35	44	52	58	68	78	92	105	117
7000	...	...	...	...	...	..	62	70	84	98	114	131	144

Life of the Rope. All things being equal, durability may be gaged by sectional area. The most economical diameters range from 1½ to 1¾ in., although for rolling-mill work 2-in. ropes are generally used.

Cases are mentioned of cotton ropes having a life of 28 to 40 years. Such cases of longevity lead to the conclusion that well-made cotton ropes are not readily subject to fatigue and have a power of quick recovery, which latter is said to be due to the fact that the ropes pull down on the working side and bulge out to their normal diameter immediately upon passing to the idle or slack side of the drive

TABLE 2 HORSEPOWER TRANSMITTED BY GOOD 3-STRAND COTTON DRIVING ROPE.

Rope Veloc., ft. per min.	½ in.	⅝ in.	¾ in.	⅞ in.	1 in.	1⅛ in.	1¼ in.	1⅜ in.	1½ in.	1⅝ in.	1¾ in.	1⅞ in.	2 in.
1000	1.0	1.6	2.3	3.2	4.2	5.3	6.6	8.0	9.5	11.2	13.0	14.9	17.0
1100	1.2	1.8	2.6	3.6	4.7	5.9	7.4	8.9	10.6	12.5	14.5	16.7	19.0
1200	1.3	2.0	2.9	4.0	5.2	6.5	8.1	9.8	11.7	13.8	16.0	18.5	20.9
1300	1.4	2.2	3.2	4.4	5.7	7.1	8.8	10.7	12.8	15.1	17.5	20.2	22.8
1400	1.5	2.4	3.5	4.8	6.2	7.7	9.5	11.6	13.9	16.3	18.9	21.9	24.7
1500	1.6	2.6	3.8	5.2	6.7	8.3	10.2	12.5	15.0	17.5	20.3	23.5	26.5
1600	1.7	2.8	4.1	5.5	7.1	8.9	10.9	13.4	16.0	18.7	21.7	25.0	28.3
1700	1.8	3.0	4.4	5.8	7.5	9.5	11.6	14.2	17.0	19.9	23.1	26.5	30.1
1800	1.9	3.2	4.6	6.1	7.9	10.1	12.3	15.0	18.0	21.0	24.4	28.0	31.8
1900	2.0	3.4	4.8	6.4	8.3	10.7	13.0	15.8	18.9	22.1	25.7	29.5	33.5
2000	2.1	3.6	5.0	6.7	8.7	11.2	13.7	16.6	19.8	23.2	27.0	31.0	35.2
2100	2.2	3.8	5.2	7.0	9.1	11.7	14.4	17.3	20.7	24.3	28.2	32.5	36.8
2200	2.3	3.9	5.4	7.3	9.5	12.2	15.1	18.0	21.6	25.0	29.4	33.9	38.4
2300	2.4	4.0	5.6	7.6	9.9	12.7	15.7	18.7	22.5	26.5	30.6	35.3	39.9
2400	2.5	4.1	5.8	7.9	10.3	13.2	16.3	19.4	23.3	27.5	31.8	36.6	41.4
2500	2.6	4.2	6.0	8.2	10.7	13.7	16.9	20.1	24.1	28.5	32.9	37.9	42.9
2600	2.7	4.3	6.2	8.5	11.1	14.1	17.4	20.8	24.9	29.4	34.0	39.1	44.4
2700	2.8	4.4	6.4	8.8	11.4	14.5	17.9	21.5	25.7	30.3	35.1	40.3	45.8
2800	2.9	4.5	6.6	9.1	11.7	14.9	18.4	22.2	26.5	31.1	36.1	41.4	47.1
2900	3.0	4.6	6.8	9.4	12.0	15.3	18.9	22.8	27.2	31.9	37.1	42.5	48.4
3000	3.1	4.7	7.0	9.6	12.3	15.7	19.3	23.4	27.9	32.7	38.0	43.6	49.6
3100	...	4.8	7.2	9.8	12.6	16.0	19.7	23.9	28.5	33.4	38.9	44.6	50.7
3200	...	4.9	7.3	10.0	12.9	16.3	20.1	24.4	29.1	34.1	39.7	45.6	51.8
3300	...	5.0	7.4	10.2	13.2	16.6	20.5	24.9	29.7	34.7	40.5	46.5	52.8
3400	...	5.1	7.5	10.4	13.4	16.9	20.9	25.3	30.3	35.3	41.2	47.4	53.8
3500	...	5.2	7.6	10.6	13.6	17.2	21.3	25.7	30.8	35.9	41.9	48.3	54.7
3600	...	...	7.7	10.8	13.8	17.5	21.7	26.1	31.3	36.5	42.6	49.1	55.6
3700	...	...	7.8	11.0	14.0	17.8	22.0	26.5	31.8	37.1	43.2	49.9	56.4
3800	...	...	7.9	11.1	14.2	18.1	22.3	26.9	32.2	37.7	43.8	50.7	57.2
3900	...	...	8.0	11.2	14.4	18.3	22.6	27.3	32.6	38.3	44.4	51.4	58.0
4000	...	...	8.1	11.3	14.6	18.5	22.9	27.7	33.0	38.8	45.0	52.1	58.8
4100	...	...	...	11.4	14.8	18.7	23.2	28.1	33.4	39.3	45.5	52.7	59.6
4200	...	...	...	11.5	15.0	18.9	23.5	28.4	33.8	39.8	46.0	53.3	60.3
4300	...	...	...	11.6	15.2	19.1	23.8	28.7	34.2	40.2	46.5	53.9	61.0
4400	...	...	...	11.7	15.4	19.3	24.1	29.0	34.6	40.6	47.0	54.4	61.7
4500	...	...	...	11.8	15.6	19.5	24.4	29.3	35.0	41.0	47.5	54.4	62.3
4600	...	...	...	11.9	15.8	19.7	24.7	29.6	35.4	41.4	48.0	55.4	62.9
4700	...	...	...	12.0	16.0	19.9	24.9	29.9	35.8	41.8	48.5	55.9	63.5
4800	...	...	...	12.1	16.2	20.1	25.1	30.2	36.1	42.2	49.0	56.4	64.1
4900	...	...	...	12.2	16.3	20.3	25.3	30.5	36.4	42.6	49.5	56.9	64.7
5000	...	...	...	12.3	16.4	20.5	25.5	30.8	36.7	43.0	50.0	57.4	65.3
5100	...	...	...	....	16.5	20.7	25.7	31.1	37.0	43.4	50.4	57.9	65.9
5200	...	...	...	....	16.6	20.9	25.9	31.4	37.3	43.8	50.8	58.4	66.4
5300	...	...	...	....	16.7	21.1	26.1	31.7	37.6	44.2	51.2	58.9	66.9
5400	...	...	...	....	16.8	21.3	26.3	32.0	37.9	44.6	51.6	59.4	67.4
5500	...	...	...	....	16.9	21.5	26.5	32.3	38.2	45.0	52.0	59.9	67.9
5600	...	...	...	....	....	21.7	26.7	32.5	38.5	45.3	52.4	60.3	68.4
5700	...	...	...	....	....	21.9	26.9	32.7	38.8	45.6	52.8	60.7	68.9
5800	...	...	...	....	....	22.1	27.1	32.9	39.1	45.9	53.2	61.1	69.4
5900	...	...	...	....	....	22.2	27.3	33.1	39.4	46.2	53.6	61.5	69.9
6000	...	...	...	....	....	22.3	27.5	33.3	39.6	46.5	54.0	61.9	70.4

English and American Systems. In England the ropes are handled under the multiple system; in America, by the continuous method. The advantage claimed for the English system is immunity from stoppage, since it is seldom that more than one rope gives way at a time.

Center Distance. It would appear that driving may be successfully accomplished, even where sheaves are almost touching, by using enough rope. A case is mentioned where sheaves are so close that a finger would scarcely pass between them.

Over- and Under-Driving. It is generally accepted that the slack side of the drive should come on top, but this is not universally so. With an erratic or fluctuating load such as obtains in rolling-mill practice, it is recommended to have the slack on the bottom, as this minimizes the tendency of the rope to wander from its appointed track. Sometimes, however, ropes persist in wandering, in which case the erection of a rope guard in comb fashion is recommended. This practice is common in England.

Sheave Diameters. In England the minimum standard is taken as approximately 30 times the diameter of the rope—in America forty to fifty times. This, however, is largely a question of speeds to sheave size, as for instance a ½-in. rope will run comfortably over a 4-in. sheave at 1000 r.p.m., a 1-in. rope over a 22-in. sheave at 3000 r.p.m., and it is only when the speed rises to 5000 ft. per min. that we meet the 30-times rule for 1-in. rope.

Centrifugal Force. The effect of centrifugal force in rope driving appears to be different from that in belt driving. In this connection Table 1 is of interest, as it would indicate that higher speeds do not detract too much from the ability to transmit power. Cases are mentioned of drives in England and France running at over 7000 ft. per min. and transmitting the highest calculated horsepower. In Cleveland, England, there is a case where the ropes are running at 7800 ft. per min. The driving sheave is 14 ft. 4 in. in diameter, making 168 r.p.m.; the driven sheave is 4 ft. 7 in. diameter, with nineteen 2-in. ropes to transmit 1400 hp. The driven sheave only shows a diameter 27.5 times that of the rope, but is giving comparatively good service.

As regards the effect of moisture, it is stated that cotton ropes are less susceptible to atmospheric changes than manila for the reason that in the first the moisture has a better chance for evaporation. This renders cotton rope practically immune from internal mildew which so often is to be found in discarded manila rope.

As regards the arc of contact, formulæ are given in the original article showing methods of proportioning the pulleys for the two cases of slack above and slack below.

Splicing. The subject of splicing is so important to the wellbeing of the system in general that, rather than have installations spliced by indifferent workmanship, expert splicing mechanics are sent out from England to all parts of the world. Experiments have been carried on with different devices of metal and other couplings with a view to dispensing with splicing, but nothing has yet been found which, in England, would be considered against the long splice. This is usually calculated at about 82 times the diameter of the rope.

Horsepower. Attention is called to Table 2, giving horsepower transmitted by good 3-strand cotton driving rope. (*Journal of The Engineering Institute of Canada*, vol. 3, no. 6, June 1920, pp. 292-298, 10 figs.)

Shear Strength of Plywood Webs

Shear Strength of Plywood Webs. Tests were conducted by the Forest Products Laboratory, Madison, Wis., to determine the shearing strength of plywood and laminated veneer webs and to determine the influence of the strength of various factors such as the number of plies, the thickness of the various plies, the relative direction of the grain in the plies, the distance between the shearing forces, the length of shearing section and the direction of the shearing forces relative to the grain of the wood.

The tests were divided into two series. The test specimens were either clamped or glued between two pairs of posts to which the load was applied. The distance between the shear forces was varied from ¼ in. to 6 in., so that the specimens were not subjected to true shear but to a combination of shear and flexural stresses.

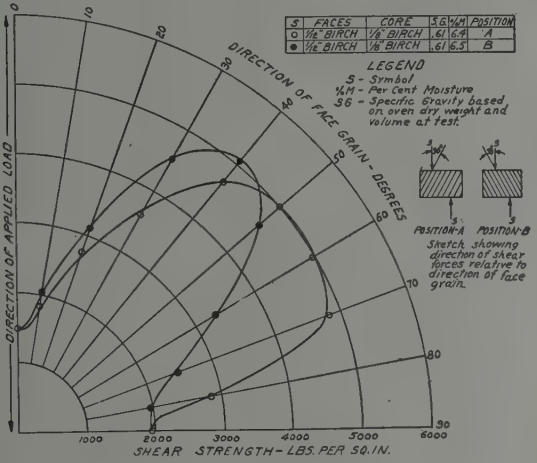


Fig. 1 Relation between Unit Shear Strength of 3-Ply Wood and Direction of Grain

The results of the tests are given in tables and curves. The tests indicate that the shear strength of 3-ply wood of various species, having all plies of one panel of the same thickness and species, is somewhat greater across the face grain than parallel to the face grain.

The unit shear strength of 3-ply birch plywood within the limits of thicknesses tested is slightly less than that for wood having five or more plies.

The unit shear strength of 3-ply wood perpendicular to the face grain and parallel-ply laminated veneer, both perpendicular and parallel to the grain, decreases with an increase in the distance between the shear forces.

The unit shear strength of birch plywood perpendicular to the face grain within the limits of the experiments decreased with an increase in the ratio of the core to total panel thickness.

The maximum shear strength of plywood and of laminated veneer having the grain of all plies parallel is obtained with angles of from 40 to 70 deg. and from 50 to 70 deg., respectively, between the direction of the applied force and the face grain. This shear strength at the optimum angle is usually more than twice that of the shear strength parallel or perpendicular to the face grain. (Figs. 1 and 2.) In Fig. 1 the two curves show the results obtained on 1/12-1/8-1/12-in. birch plywood for each of the two positions in which the specimen may be tested for each angle between face grain and direction of applied load. In other words, the two points for a given angle represent the unit shear strength of the plywood with shear forces in opposite directions.

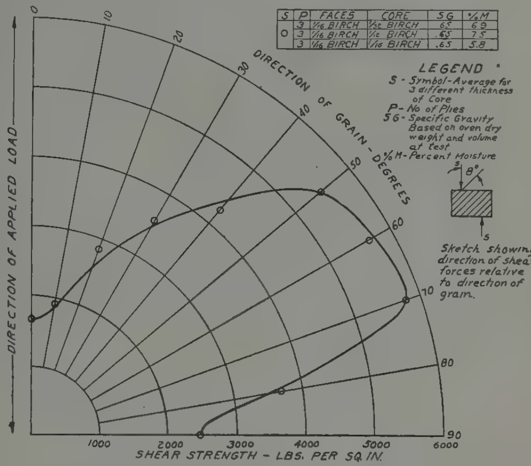


Fig. 2 Relation between Unit Shear Strength of Parallel-Ply Laminated Veneer and Direction of Grain

The data determine that the shear strength of plywood is dependent, in general, upon the specific gravity of the species; and the higher the specific gravity the greater will be the shear strength.

These tests have confirmed the existence of an important difference between plywood and ordinary wood in shear, namely, the nature of the failure. Ordinary wood fails suddenly and completely. In the case of plywood, the failure is more gradual and less complete, as in plywood under shear the plies fail first in shear along the grain but the failures in successive plies are at right angles to each other.

The shear strength of plywood and parallel-ply laminated veneer, as shown in Figs. 1 and 2, is dependent to a very large extent upon the direction of the shear forces relative to the face grain. (Engineering Division, Air Service, McCook Field, *Technical Orders,* No. 14, March 1920, pp. 47-60, 6 figs., *epA.* Abstracted by special permission of the Office of the Director of Air Service, War Department)

Geared Turbines with Double-Reduction Gear

Geared Turbines with Double-Reduction Gear. For the S.S. *Corrientes,* the Parsons Marine Steam Turbine Co. has designed a turbine installation with several novel features.

The total horsepower which the turbines are designed to develop is only 3000 hp., and yet there are three ahead turbines arranged in series, and two astern turbines fitted respectively within the low-pressure and the intermediate-pressure casings. (Fig. 1A.)

The arrangement of gearing is unusual. The high-pressure and intermediate-pressure turbines (Fig. 1B) both engage with one wheel; the intermediate-pressure turbine being arranged vertically above this wheel. The low-pressure turbine engages with a second wheel on the opposite side of the propeller shaft. Fig. 1C shows the arrangement of the gear box.

In the turbines themselves dummies are absent, the thrust being taken on Michell blocks as shown in Fig. 1C. Carbon glands are used for the high-pressure and intermediate-pressure turbines. The elimination of the dummies reduces to quite low values certain leakage losses which have hitherto served to limit the commercial efficiency of the smaller sizes of the Parsons type of turbine.

The theoretical stage efficiency of a reaction turbine is higher than that of an impulse turbine since each row of blades, whether fixed or moving, constitutes a pressure stage, and the losses in a

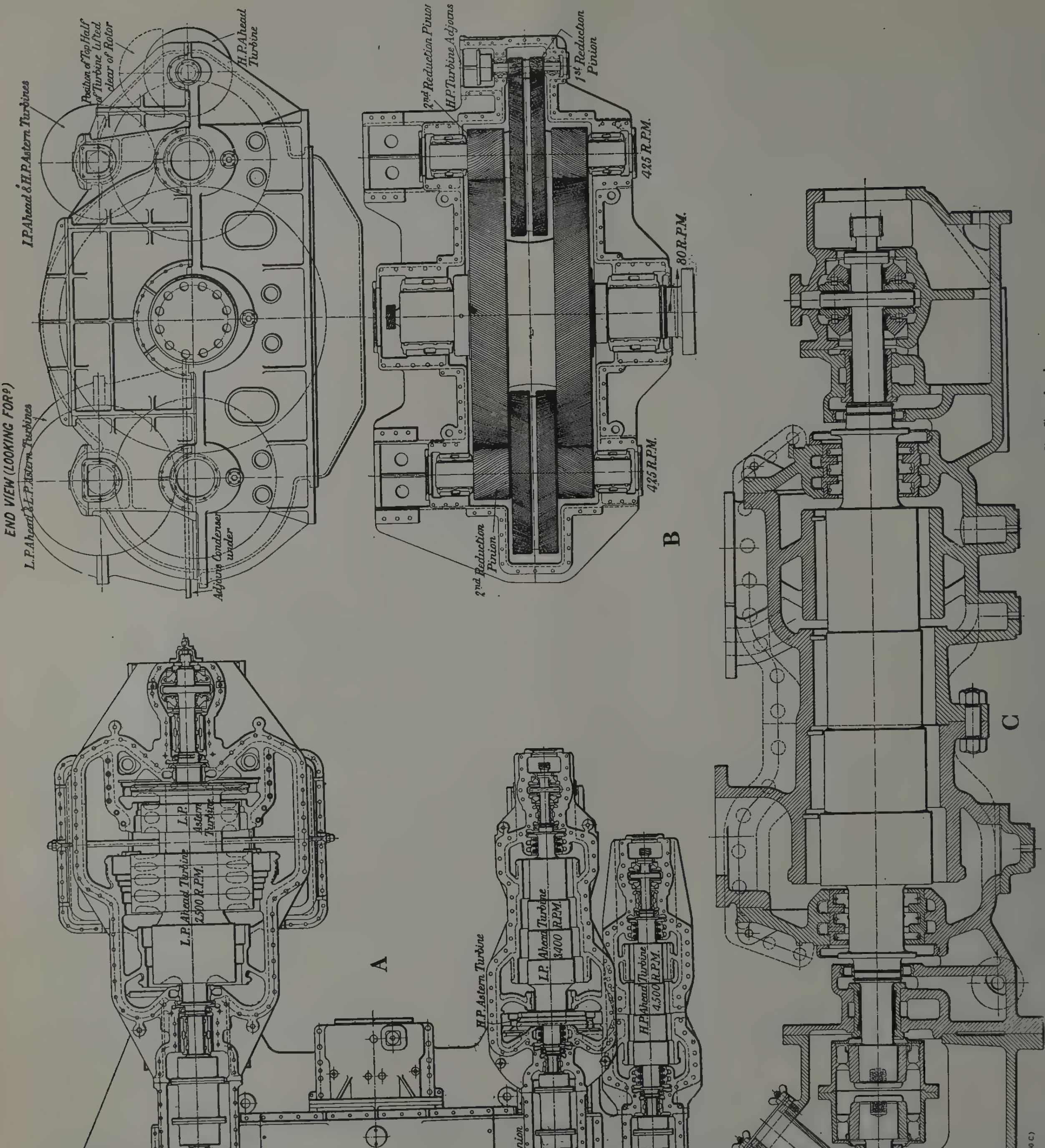


FIG. 1 PARSONS GEARED TURBINES WITH DOUBLE REDUCTION GEAR ON S. S. *Corrientes*

pressure stage thus consist of nozzle friction only, while in each pressure stage of an impulse turbine the bucket losses must be added to the nozzle losses. As a consequence, it is a noteworthy fact that in water-turbine practice the efficiency of the reaction machine is not less than of the impulse type, although the latter is generally free from the leakage losses and the disk friction which are unavoidable with steam turbines of the same type. It is obvious, therefore, that the intrinsic efficiency of the reaction blading is higher than that of impulse blading, but in the past this has been counteracted by the larger leakage losses. It is to reduce these that the dummies have been eliminated and in a further effort in the same direction the "end-tightening" principle has been applied to the high-pressure blading. With this system the turbine is assembled and driven in the shops with no clearance at all at the high-pressure blading, which is thus worn to a uniform bearing and the working clearance is then adjusted to about one-half of the radial clearance which would otherwise be necessary.

The blading is shrouded and the shrouding taken off to a thin edge which abuts on the foundation ring at the root of the following or preceding row of blades. The rotor spindle is adjustable axially and thus the thin edge of the shrouding can be brought into actual contact with the opposing surfaces.

If the turbine is started up in this state it will wear its own clearances, which are therefore as small as could be. It is said that no trouble is experienced from the heat generated by the friction during this period of wear, this being explained by the mechanical principle said to be first formulated by Sir Charles Parsons, namely, that when two unlubricated surfaces are in relative motion and are liable to touch, one of the surfaces should be reduced to a mere fin which is insufficiently rigid to cause distortion of other parts by being heated and is too light to produce much heat through its wearing away.

It is claimed that this type of turbine is particularly adapted for working with superheated steam. The rotors, though of small diameter, are short and stiff, while the use of the end-tightened blading makes large radial clearances possible in the region where the steam temperature is high. (*Engineering*, vol. 110, no. 2850, Aug. 13, 1920, pp. 211, 212, 214 and 2 sheets of plates, 7 figs. besides the plates, *dA*)

Short Abstracts of the Month

AERONAUTICS (See also Internal-Combustion Engineering; Measuring Instruments)

Alula Wing. Data on the Alula wing developed by the Blackburn Aeroplane Co. and used in the Pelican 4-ton air truck of the Commercial Aeroplane Wing Syndicate, Ltd.

The Alula wing is claimed to be a new wing type. It is stated that a method of designing a concrete wing shape was evolved enabling the designer to vary all features of a wing in unison whenever a particular one had to be changed, in such a manner as not to upset their interrelation. No data as to the mathematical method referred to are, however, presented beyond general statements. Fig. 1 may give some indication as to the character of this wing. (*Aeronautics*, vol. 19, no. 354, July 29, 1920, pp. 96-97, 3 figs., *dg*)

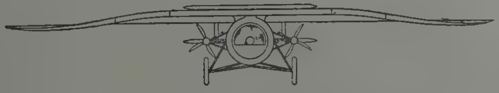


Fig. 1 Pelican 4-ton Air Truck with Alula Wing

ARTILLERY (See Machine Shop)

AUTOMOTIVE ENGINEERING (See Measuring Instruments)

FORGING

Defects in Drop Forgings, P. Rowley. Rejected drop forgings may owe their rejection to defects in the steel from which they are made. If a billet has a crack or lap which is oxidized inside, the chances are that it will extend during working, especially if the metal is spread by a peg in the die. Cracks which do not open during forging may extend during the oil and water quenching. Piping and ghost lines are also found to be a source of trouble.

Some troubles of the drop forger may be due also to segregation in the metal, especially in alloy steel, of which segregation there are several types. In one case of 3 per cent nickel-chrome steel worked up into connecting rods trouble was encountered during machining. Investigation showed that while the outer layer of a rod cut through the center longitudinally had a carbon content of 0.37 per cent, the inner part approximated to 1 per cent, the segregation of carbon being apparently due to the method adopted by the steel maker to prevent piping. Some of the troubles in drop forging are due to improper design of the parts, traceable to lack of drop-forge knowledge on the part of the designers and draftsmen. These people sometimes fail to differentiate between the flow of a molten metal and the flow of a plastic but at the same time a solid material. In casting, metal may flow from two directions into the same part of the mold to form a solid mass on cooling, but plastic metal cannot run together from two directions to form a good forging owing to the oxidation and decarburization of the exposed surfaces. In this connection, the usual H-section connecting rod as commonly used in internal-combustion engine work is cited as an example of a design but poorly suitable for drop forging. The remedy would be to enlarge the radius in the flute so that the metal might run into the sides of the H-section before flowing into the flash. The adoption of a fish-back design of connecting rod wherever possible would result in saving in die manufacture. (Paper before the Association of Drop Forgers and Stampers at Birmingham, abstracted through *Engineering*, vol 110, no. 2849, Aug. 6, 1920, pp. 185-186, *p*)

FOUNDRY

British Practice in Light Steel Casting

Light Steel Castings, R. J. Dunderdale. This type of casting was not extensively used in England prior to the war, one of the reasons for it being that the small converters which were then a source of steel for this type of work did not produce an entirely suitable metal. The situation, however, has become entirely different with the introduction of the electric furnace.

The types of furnace chiefly in use in England for light steel castings are the Schneider, Heroult and Electro-Metals in sizes varying from ½ ton to 15 tons at a charge. The size suitable for general work in castings ranging from 14 lb. to 140 lb. in weight is the 2-ton furnace, but even then it is desirable to have the furnaces graduated in sizes and used near the type of casting which they would be chiefly employed on.

The sand required for this type of molding differs materially from the usual iron foundry sand. Its physical condition should be hard, sharp and not easily friable. Chemically, it should contain 97 to 98 per cent of silica and as little matter of other kinds as possible. The sand itself should not pass through an 80-mesh screen as its texture will be rendered decidedly finer than this by the clay used for bonding. The best clays for this purpose contain about 30 per cent of alumina and as little organic matter as possible, (a certain amount of iron is said to be an advantage). The moisture of the final mixture which must be good can be as much below 4 per cent as will allow the sand to hold together well.

Baking the mold and painting it with tar from time to time used to be common practice prior to the war. As a matter of fact, however, for a vast majority of light steel castings now made a green mold is entirely satisfactory. A baked mold is still used, however, for very thin work and cored pressure work, providing the mold is made suitably weak and well vented.

A good deal of trouble is experienced from blowholes when the molding is not right, and, in this connection it is stated that the practice of piling is probably not so successful as might be expected, owing to the steam generated in the lower molds getting into the upper molds before the steel does and preventing the exit of gases. This same trouble is apt to occur when two patterns are cast separately in the same box.

Core making in a light-steel-castings foundry has now become a very important part of molding. As regards the sand used in core making, one similar to but rather finer than the facing sand for the molds is desirable.

The causes of the more important failures in light steel castings are discussed in some detail. The three main causes mentioned are short-run castings, slag, and blown and spongy castings.

For repetition work on light steel castings the jolt-ramming type of machine appears to be particularly suitable. In a steel casting it is essential that the face should be hard and the backing moderately weak, in order that the high temperature of the metal and its weight should not break up the face in the first place and the slower-cooling portions shall not be drawn apart by a mold which is uniformly too tightly rammed. The jolt-ramming machine provides this.

As regards fettling, the usual tumbling boxes have not been found sufficient for the hard burning on which takes place in the case of a steel casting, especially in the angles and curves of intricate specimens. Sand blasting has to be resorted to, preferably with steel shot and nozzles.

The development of the light casting industry in England faces the competition of Switzerland, Belgium and Germany, where the same industry appears to be quite firmly established. At present the rate of exchange is in favor of England and it is stated that the future of the industry should be good for some years to come in any event, but there are several weak spots which are apt to be uncovered when competition begins to arise. As a way to help establish this young industry while it is now in a healthy infancy, it is recommended that the light steel castings users combine with the present manufacturers and arrange to parcel out the work to these manufacturers in such a way that one firm is only engaged on two or three standard types of job, this covering the field of repetition work. With regard to the jobbing work, any small quantities of this type should be reserved entirely for two or three foundries suitably equipped with proper range of furnaces. (*Engineering*, vol. 110, no. 2849, Aug. 6, 1920, pp. 167-168, *p*)

FUELS AND FIRING

Sawmill Refuse as Fuel for Electric Railways

FUEL SELECTION FOR ELECTRIC RAILWAYS, Darrah Corbet. Data of tests and experience with sawmill refuse as used for fuel by the Portland Railway Light and Power Company of Portland, Ore.

Sawmill refuse ranging from fine sawdust to large blocks of hardwood, at least 1 ft. square, is available for fuel in power stations in many sections of the country, particularly in the Northwest.

It has a fairly high heating value (8500 B.t.u. per lb. of dry non-resinous wood) and can be readily stored for a considerable length of time without very material depreciation in the fuel value and without involving great fire risk. Moreover it can be fed into furnaces not primarily designed for this kind of fuel, although it is probable that better efficiency could be secured with special furnace design.

The original paper gives curves of comparative values of wood and fuel oil (evaporation from and at 212 deg.), Fig. 2. The use of this curve is based on the assumption of oil at $1 a barrel and 12 lb. of evaporation per pound of oil; sawmill-refuse fuel containing 45 per cent moisture and weighing 20 lb. per cu. ft. and efficiency 60 per cent.

Starting with the value of 12 lb. of evaporation per pound of oil, directly above this at the point of intersection with the line indicating the pounds of oil per barrel, we note that on the left the total evaporation per barrel of oil is 4080 lb. Transferring this below 4080 lb. evaporation across to the right, we note that over the figure $1 per barrel the cost of 1000 lb. of steam is about 24¼ cents.

Starting again with 45 per cent moisture in the sawmill fuel and going to the left to the point of intersection of 60 per cent efficiency, we note that the evaporation per pound of wood is approximately 2.3 lb. water, or with 4000 lb. per unit this is equivalent to about 9200 lb. of water per unit of fuel. Carrying this to the right to the point of intersection with the line indicating cost of steam 24½ cents per 1000 lb., we note $2.25 as the equivalent cost of a unit of fuel.

On the same basis, if oil cost $2 a barrel the equivalent cost of sawmill refuse would be twice the above, or $4.50 a unit. In this manner a ready reference is secured and the curve can probably be read far more accurately than will be the assumptions made.

The use of powdered coal in several power stations in the Northwest is discussed. At the plant of the Pacific Coal Company at Renton, Wash., a large amount of sludge coal accumulated during the past 15 years. In its present form this fuel is practically useless, but after being pulverized is said to give an average evaporation of 5 lb. of water per pound of coal.

It is also stated that the Milwaukee Electric Railway and Light Company has decided to install a powdered-coal burning equipment for a new 40,000-kw. station.

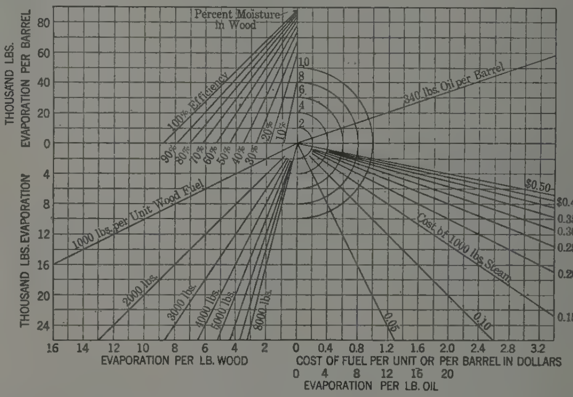


FIG. 2 CURVES OF COMPARATIVE VALUES FOR WOOD AND OIL FUEL (EVAPORATION FROM AND AT 212 DEG. FAHR.)

On the whole, the author comes to the conclusion that the use of oil fuel will probably be curtailed and more consideration will be given to coal. There is a limited field for sawmill refuse, but better and more efficient means of handling and burning it are desirable. (*Journal of the American Institute of Electrical Engineers*, vol. 39, no. 8, August 1920, abstracted pp. 715-732, 4 figs., 12 tables. Also abstracted in *Electric Railway Journal*, vol. 56, no. 7, Aug. 14, 1920, pp. 314-315, 1 fig., *cp*)

ENGINEERING MATERIALS

French Investigation on the Hardening of Carbon Steel

INFLUENCE OF THE VELOCITY OF COOLING ON THE HARDENING OF CARBON STEEL, Portevin and Garvin. The operation of hardening which consists essentially in a more or less rapid cooling from a temperature T (which may be called the temperature of hardening) depends only on the following two variables: (1) the state of the metal at the beginning of the cooling, that is, the temperature T; and (2) the law of cooling. It is the law of cooling that the authors discuss in the present paper.

This law of cooling for a given steel depends on the following factors:

A—Temperature at the beginning of cooling, T

B—Mass, shape and dimensions of the piece of steel treated

C—Location of the point under consideration in the piece of steel

D—Nature of the bath, that is, the medium by which cooling is brought about. The action of this medium in its turn depends on its physical properties, namely, its specific heat, its latent heat of vaporization, heat conductivity and viscosity

E—Temperature of the bath, which may vary during the process of cooling depending on the relative masses of the bath itself and of the piece of metal immersed therein

F—Stirring of the bath with respect to the piece of metal

G—State of the surface of the metal piece

H—Temperature at the end of the cooling, or temperature at withdrawal from bath.

For a given point in the piece of metal this law of cooling is completely determined by a curve expressing $\theta = f(t)$, which gives the variation of the temperature θ as a function of the time t. For similar laws of cooling this curve is sufficiently determined by the average velocity of cooling between two given temperatures or by its inverse, namely, the time necessary to traverse a given interval of temperature. The writers adopted as a characteristic value of the velocity of cooling the time necessary for the temperature to change from 700 deg. cent. to 200 deg. cent. which they denote by τ (700-200), or simply by τ.

The paper investigates the following two questions: First, How does the law of refrigeration, or, in other words, the value of τ, vary in accordance with the variation in the factors enumerated from A to H and second, What relation exists for a given steel and a given initial temperature of the process between τ and the final state of the steel as determined by the hardness and the micrographic aspect thereof?

The original paper gives the data secured in the form of curves and tables. Only the most important results obtained in this interesting investigation can be reported here.

It has been found that there is a critical region for the velocity of cooling within which the thermal phenomenon denoting the internal transformations in the steel suddenly changes its character and position in the scale of temperatures. The authors call it the critical velocity of hardening in predetermined conditions defining the initial state of the metal and the law of cooling. The following notation is introduced. Ar' is the anomalous state very clearly defined on the curves at about 650 deg. cent., and Ar'' a change in the shape in the curves occurring around 300 deg. cent. The transformation denoted by Ar' and occurring around 650 deg. cent. corresponds to the formation of troostite, and the transformation at the lower temperature Ar'' corresponds to the formation of martensite.

There is therefore a critical velocity denoting the passage from troostitic hardening to martensitic hardening. A parallel phenomenon is observable in measuring hardness. There, there are two regions—one of great hardness around 600 Brinell units and the other of medium hardness around 400 Brinell units. These the authors call martensitic hard hardening and troostitic soft hardening.

Extensive data are presented to show the distinction between these two states.

As regards the influence of the chemical composition on the critical velocity of hardening, the authors claim that this critical velocity is at its minimum when the steel is in the neighborhood of the eutectic. Manganese plays an important role from the point of view of critical velocity, and, for example, a sample of steel with 1.10 per cent of carbon and 0.40 per cent of manganese has a martensitic type of hardening, while a similar sample with 1.07 per cent carbon and 0.08 manganese gave a troostitic hardening.

As regards the rate of cooling approaching the critical rate of hardening, the authors claim that the apparent contradictory behavior observed by various experimenters in reference to the influence of the temperature of cooling may be explained by the difference in the size of the sample on which observations were made. If the sample is small or if the examination is limited to the surface of the sample it will be found that the temperature of hardening has no material influence on the result, because under these conditions the process is always carried on at a rate of cooling considerably below the critical. On the contrary, if the sample is large or the interior is taken into consideration and conditions approaching the critical velocity have been reached, a very different conclusion as to the influence of temperature must be arrived at. If the size of the sample and conditions of cooling are such that at the center of the sample soft troostitic hardening takes place, there is, naturally, between the center and the surface a region martensitic-troostitic in which the critical rates have been exceeded. The location of this region shifts with the initial temperature of hardening, and the thickness of the zone of hard martensitic hardening varies. This is why the temperature of hardening becomes of importance as it affects the penetration of the hard hardness and the hardening of large pieces.

The other parts of this very interesting paper cannot be abstracted because of lack of space.

Among the conclusions attention is called to the following statement: If, with the same steel and the same initial temperature of cooling the rate of cooling is increased, the lowering of the point of transformation does not occur in a regular manner and there is a discontinuity or at least a variation of a non-gradual character in the location of the point of transformation on cooling. After the point of transformation has gone down gradually, the anomaly on cooling passes from the position Ar' to the position Ar''; whence the notion of *critical velocity of hardening.*

As a matter of fact, this expression "critical velocity of hardening" is not precise and should be replaced by the designation of the critical zone of the velocity of hardening, taking into consideration the phenomenon of the presence of a double point of transformation which leads to the appearance of troostite and martensite.

For carbon steel 350 deg. cent. appears to be the upper limit of temperature at the withdrawal from the bath in case of repeated hardenings or for medium hardness. Such a temperature will not cause a marked decrease of hardness other than that brought about by the slight anneal occurring during the second period of the operation. (*Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* vol. 132, no. 3, May-June 1920, pp.

HANDLING OF MATERIALS

Comparison of Separation of Pulverized Materials by Screens and Air Currents and Description of Raymond System

Air Classification of Pulverized Material, S. B. Kansowitz. The means employed to classify pulverized or ground material have so far been screens or air currents. It is the latter which is described here.

The use of screens or screening cloth is claimed to be limited to a comparatively coarse product. When very fine separation is attempted the screens tend to clog, decreasing the capacity and returning to the mill tailings which contain a high percentage of fine particles. With hard abrasive material the screen openings are rapidly enlarged and then give a product coarser than desired.

Air separation is claimed to avoid all these difficulties. A real air separator should be an integral part of the mill and should be able to remove the ground material from the grinding surfaces as fast as produced. This can be accomplished only by having the air enter underneath the grinding surfaces and blow the ground particles up and away from the rolls.

The separator should be dustless in operation and capable of maintaining uniform product under all reasonable changes of air velocity and air density. Furthermore, it should be so designed that fineness of the finished product could be changed on short notice and without shutting down the equipment.

Figs. 3 and 4 show cross-sections of the Raymond system of air classification. The material from the grinders is drawn into a fan and then blown into a cyclone dust collector. After traveling in the comparatively small-sectioned discharge pipe the material enters the large collector and is compelled to travel in a circular path. The centrifugal force thus produced causes the material to hug the walls of the collector and eventually drop through the bottom as finished product. The air freed from the material passes off through the top of the collector into the return air pipe which delivers the air back to the port holes under the grinding chamber. These ports are surrounded with an air-tight casing. In the separator the whirling currents travel in a larger and larger

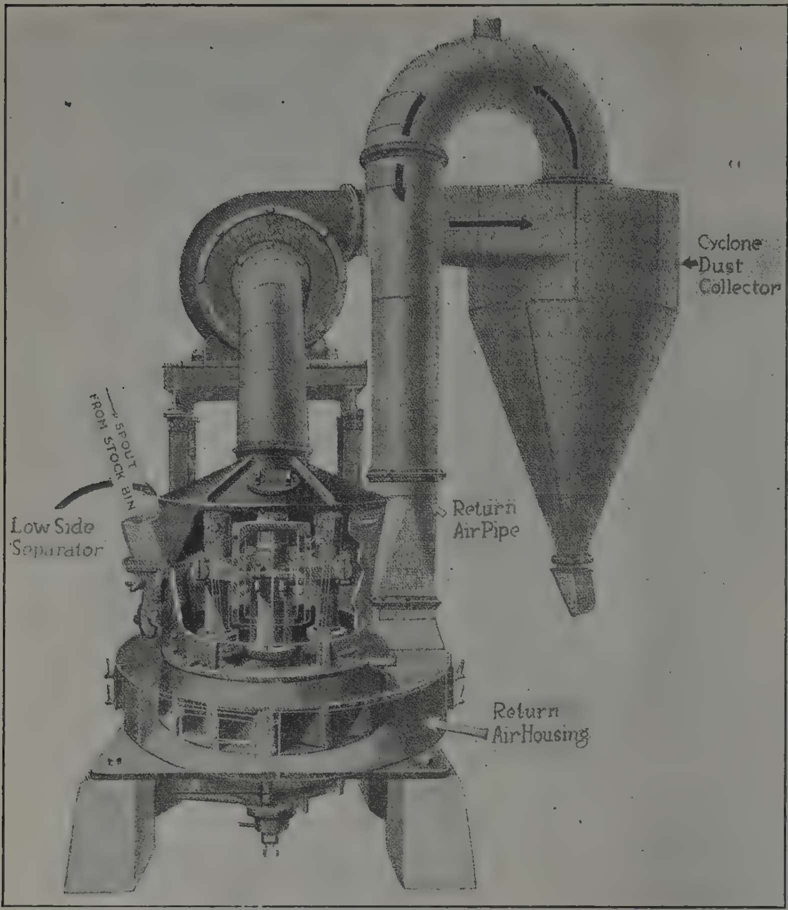


Fig. 3 Raymond System of Air Separation

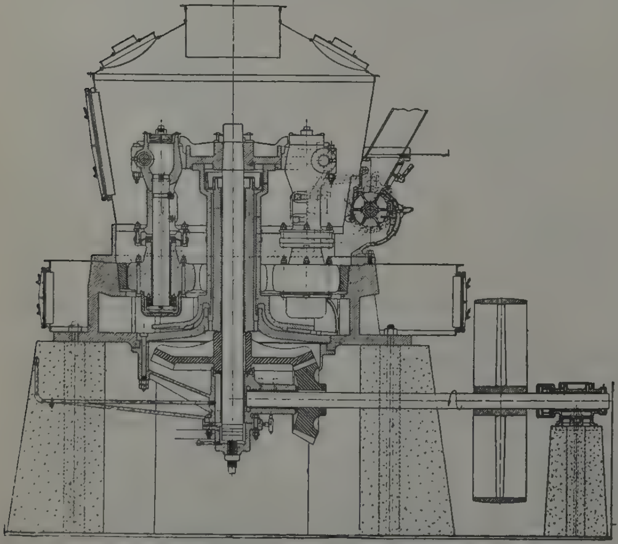


Fig. 4 Section of Mill and Air-Separator Connections in the Raymond System of Air Separation

circular path due to the increased radius of the separator. Because of this the coarser particles are constantly being thrown against the sides of the separator and brought back to the mill to be reground, while the finer particles of which the centrifugal force is not great enough to overcome the fan suction, pass into the front intake.

The important feature of this type of separator is that the separation does not depend on the air velocity or air density. Because of this high air velocity can be employed.

Among the advantages of air separation is claimed the fact that a finer product can be obtained than by the use of the finest screens. The full import of this statement may be realized when we bear in mind that there are screens in the market of 350 meshes to the linear inch, or 122,500 holes per square inch. Air separation may also be usefully employed with materials which either are, or tend to become sticky, such as resin, pitch, shellac and various gums. (*Compressed Air Magazine*, vol. 25, no. 7, July 1920, pp. 9722-9723, 3 figs., *dc*)

INTERNAL-COMBUSTION ENGINEERING

Rotary Air-Cooled Engine with Variable Piston Stroke

Zeitlin Variable-Stroke Aero Engine. Description of a 220-hp. engine shown at the recent International Aero Exhibition, London.

The engine is of the rotary air-cooled type with nine cylinders and its particular interest lies in the fact that the piston stroke is varied through the cycle. This is accomplished (Fig. 6) by fitting an eccentric to the big end of each connecting rod and rotating the eccentrics around the crankpin at half the engine speed by means of gearing. The cycle of operation is as follows: On the working stroke each piston of the engine travels inward a distance of 181 mm. returning on the exhaust stroke for a distance of 203.5 mm. so

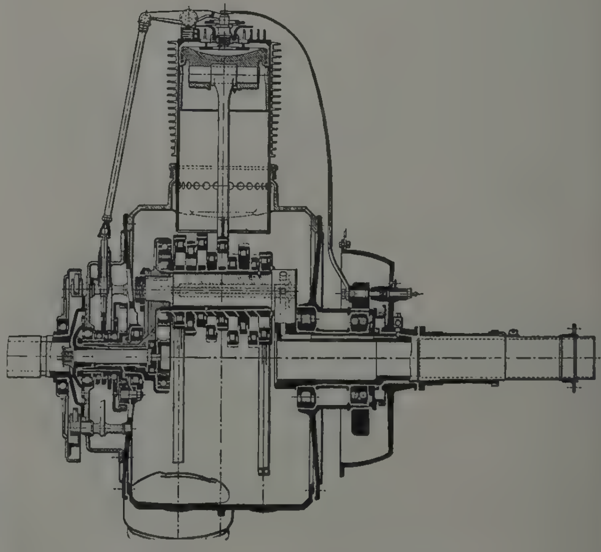


Fig. 5 Zeitlin Variable-Stroke Aero Engine, Showing Drive of Eccentrics on Crankpin

as to clear the cylinder of the gases of combustion more thoroughly. The exhaust valve remains open for the greater part of the suction stroke, but after it has closed the piston continues to move for a total distance of 226 mm., uncovering inlet ports in the cylinder liner near the end of the stroke. These inlet ports are connected with the crankcase and the partial vacuum in the cylinder is sufficient to draw in gas from the crankcase when the ports are uncovered. On the compression stroke the piston travels a distance of 203.5 mm.

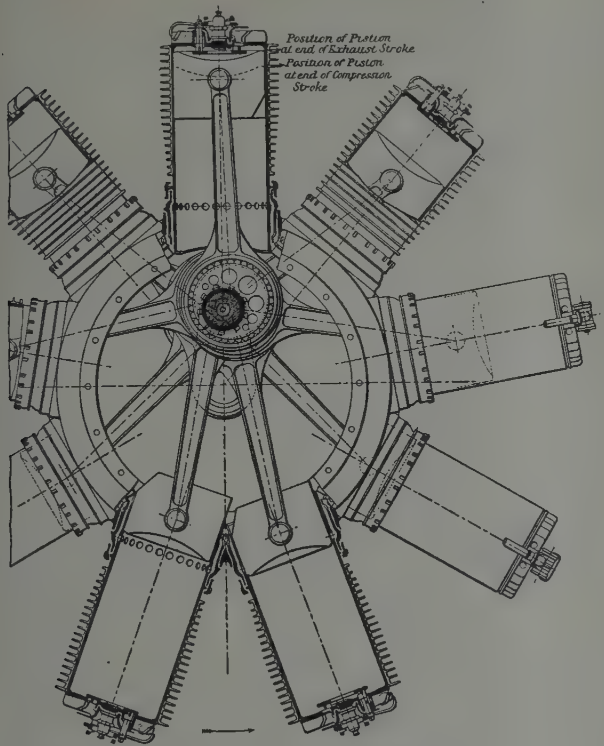

Position of Piston at end of Exhaust Stroke
Position of Piston at end of Compression Stroke

Fig. 6 Zeitlin Variable-Stroke Aero Engine, Showing Two Positions of Piston through the Cycle

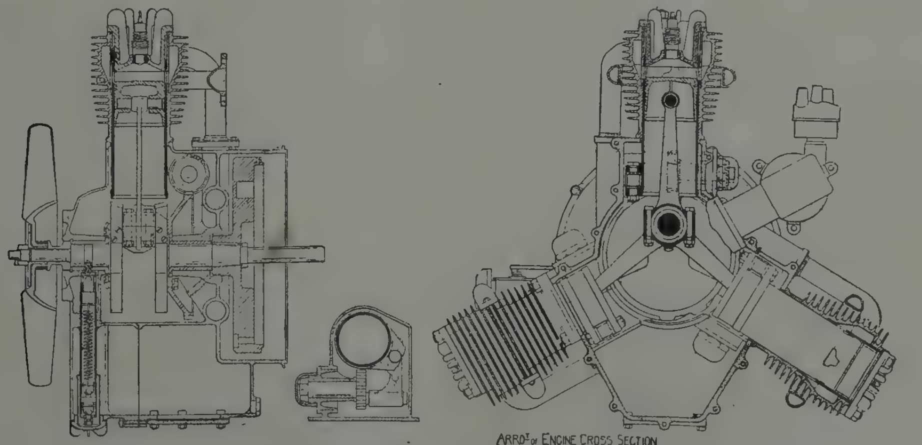


Fig. 7 Radial 3-Cylinder Motor-Car Air-Cooled Engine with Burt Single-Sleeve Valve

The method of driving the eccentrics on the crankpin is of interest. To reduce the friction as much as possible, it is desirable to rotate the eccentrics in the same direction as the engine. One way to do this is to fit a small idler pinion between the fixed wheel on the engine center and the gear attached to the eccentrics. This, however, would involve certain difficulties and instead of the idler wheel a toothed ring encircling both gears is employed. This toothed ring (Fig. 5) is supported on large ball bearings. The exhaust valves, of which there are nine and which are of the annular type, are operated by three cams driven by epicyclic gearing.

In connection with the exhaust-valve mechanism, the engine is provided with a device to compensate for changes in altitude. The exhaust valve is normally kept open for a certain fraction of the suction stroke arranged, say, to allow the admission of a quantity of air calculated to give the correct compression at a height of 15,000 ft. The quantity admitted at lower altitudes with the same arrangement would, however, be excessive, but reduction of pressure is accomplished by opening the exhaust valve for a certain part of the compression stroke so that some of the air is expelled before it has had time to mix with the gas admitted through the ports.

The engine is said to develop 220 b.hp. and the weight per b. hp. is well below 2 lb. (*Engineering*, vol. 110, no. 2848, July 30, 1920, pp. 138-139, 3 figs., *d*)

Motor-Car Air-Cooled Engine with Burt Single-Sleeve Valves

Air-Cooled Sleeve-Valve Engine. Description of a radial 3-cylinder motor-car air-cooled engine fitted with the Burt single-sleeve valve. The engine as shown in Fig. 7 has a bore and stroke of 80 by 90 mm. (3.14 in. by 3.54 in.), and its most interesting feature is the sleeve valve, a construction which presents unusual difficulties in an air-cooled engine because of the conditions for heat disposal which are present. In this case the sleeve is given a movement which is a compound of up and down and rotational movements, so that a point marked on the sleeve would in a complete cycle trace an ellipse.

The sleeve is operated by means of a small crankpin carrying a short horizontal connecting rod, the small end of which is attached to lugs at the bottom of the sleeve by means of a pin having a vertical axis, that is, an axis at right angles to the axis of the crankpin.

The place of the usual camshaft is taken by a small crankshaft driven at half engine speed with separate crankpins for each cylinder. There is a separate crank for each cylinder driven by means of skew gearing, the crown wheel of which is mounted at the side of the main crankshaft remote from the fan.

One of the features of the valve system, Fig. 8, is that inlet and exhaust ports are placed alternately round the cylinder, and the ports in the sleeve therefore act alternately for admission and exhaust, which helps to cool the sleeve. The cold incoming mixture circulates round an annular space at the top of the cylinder, cooling the latter and also the cylinder head. (*The Autocar,* vol. 45, no. 1296, Aug. 21, 1920, pp. 317-318, 5 figs., *d*)

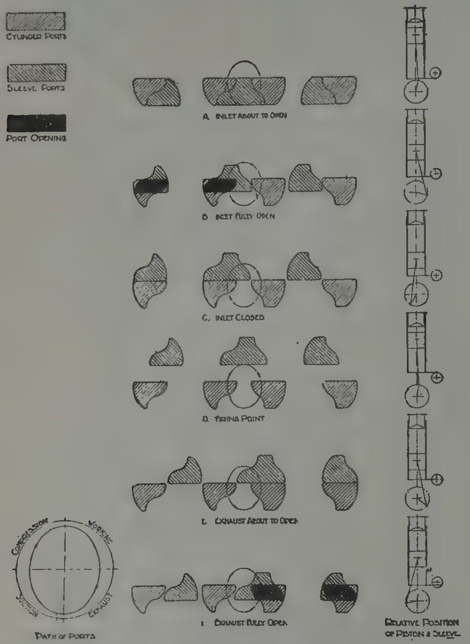


FIG. 8 DIAGRAM SHOWING RELATIVE POSITIONS OF THE INLET AND EXHAUST PORTS DURING A COMPLETE CYCLE IN ONE CYLINDER OF THE BURT SINGLE-SLEEVE-VALVE ENGINE

MACHINE SHOP

Seriatim Theory of High-Speed Punching Applied also to Perforation of Armor Plate by Projectiles

THE LAWS OF HIGH-SPEED PUNCHING, Capt. T. J. Tresidder. Paper issued by the War Office, Ordnance Committee Press, presenting a novel theory of punching which the author calls the Seriatim Theory of High-Speed Punching.

The theory is of importance also to artillerists as it enables them to determine the remaining velocity of a projectile perforating a given plate at a given striking velocity.

The method of procedure according to this theory is to separate the energy expended in perforating into its three components, namely, that expended on punching, that expended on overcoming friction, and that expended on giving velocity to the expelled plug, the laws governing the punching of a plate by a projectile being claimed to be exactly the same as those known to obtain in the case of plates punched in a punching machine.

The basic argument brought forward is to the effect that mean endlong pressure on the shell due to resistance to punching decreases as the velocity of the shell increases from the bare perforating velocity upward.

There is an important distinction between the blow the projectile can give and that which it does give. Up to bare perforating velocity it gives its all. Beyond the perforation point the blow given is only the maximum the plate can return, and the rest of its possible blow the shell carries on with it.

When a moving body—say, a shell—collides with a stationary one—say, a plate—the action and reaction between them, which are equal to each other, obviously cannot exceed the maximum of which the more feeble is capable. If the blow is arrested, the shot is the more feeble and the mean pressure will depend on its energy. If it is not arrested the plate is the more feeble and the mean pressure will depend on its resistance. If the latter decreases—according to the theory propounded—as speed of attack increases and makes the time available less sufficient for calling into action all the resources of the plate, pressure must decrease with it. Therefore, a shell which encounters a plate with only just enough velocity to perforate it will, according to this theory, be more stressed by, and will undergo more endlong pressure from, the plate's resistance than if its velocity were twice as great.

Consider the force required to punch, as in a punching machine, four plates, each ¼ in. thick, arranged with three thinner hard plates, which have been already perforated, between them. The thin hard plates—that is, the second, fourth and sixth of the pile—will then act as holders-up for the first, third and fifth, the seventh being held up by the die of the machine as usual. Clearly the pressure that must now be applied to the punch to perforate the four ¼-in. plates—1 in. altogether—is theoretically only the same as would be needed for one ¼-in. plate. That is to say, if a punch can deal with a plate by punching one-fourth of its thickness at a time, it need only have behind it one-fourth the pressure otherwise necessary. Similarly, if a plate is made up of a thousand or ten thousand laminæ which can be separately punched seriatim, the theoretical force or pressure between punch and plate need only be one-thousandth or one ten-thousandth of that required for the solid plate. The distance separating the laminæ need only be sufficient to allow each to fail to shear before the next is seriously engaged, and as this distance will certainly be less as the speed of punching is greater—for the higher the speed the more thoroughly is each lamina held up by its own inertia—it is not inconceivable that as the velocity increases toward the infinite, there will be, in the case of a solid plate, a nearer and nearer approach to a sort of seriatim punching of hypothetical laminæ, whose number approaches infinity and whose thickness and distance apart approach zero.

This is followed by an interesting discussion of the classical case of a soft candle fired as a projectile through a wooden board.

The author's theory was checked by means of tests where measurement was made of the loss of energy suffered by certain projectiles in perforating certain plates at velocities far above those just necessary to carry a shell through. The bare perforating velocities were known. Knowing the energy lost by the projectile when it is just perforated and calling it *A,* and also knowing the energy lost by the same projectile in perforating the same plate at a higher velocity and calling it *B,* it was only necessary to compare *A* and *B* to test the truth of the main assertion of the Seriatim Theory, namely, that mean pressure due to resistance to punching is less as perforating velocity is greater, which proved to be true in every case.

The approximate net energy absorbed in overcoming the plate's resistance to punching at the high velocity—based on the observed remaining velocity—was compared with that at the low velocity. Their relation to each other was found every time to be, within reasonable limits of observational accuracy, inversely the same as the relation of the corresponding striking velocities.

This amounts to experimental proof of the statement that the net energy absorbed in the punching of a given plate by a given projectile, and also the mean pressure F on the projectile due to the plate's resistance to punching, varies inversely as the striking velocity.

It will be seen that, according to the Seriatim Theory, as V proceeds from perforation value to infinity, "pressure exerted," "work done", and "time taken" in overcoming the plate's resistance to punching, all diminish toward zero; but "power exerted", which is work divided by time, remains the same at all velocities, if time is fixed, since, however near to zero "work done" and "time taken" may be brought, their relation to each other remains unchanged, both varying inversely as the first power of the velocity.

Bearing in mind, then, that in the perforation of one body by another, energy is expended in three distinct ways, viz., punching, friction overcoming and plug propelling; and that of these we are at the moment dealing with only one, namely, punching, the following new dynamical law seems to result from the arguments of this section:

When any given body, in virtue of kinetic energy, passes completely through another given body without undergoing any change whatever of its own form or dimensions, the power it exerts in effecting the necessary rupture of the material of the perforated body is constant for all velocities.

The report covers many more features of apparently great importance which cannot be abstracted, partly because of lack of space and partly because of insufficient explicit data in the abstract from which this one is taken. (*The Engineer,* vol. 130, no. 3371, Aug. 6, 1920, pp. 126-127, *dtA*)

Comparison of British and American Practice in Hot Stamping

Steam and Friction Stamps For Hot Stamping, W. H. Snow. The author compares American and British practice in the matter of production of stampings and comes to the conclusion that American methods are far superior to the British. He explains this by the fact that the American stamper has had the advantage of a demand for quantities altogether beyond the orders usually met with in England and hence has been able to specialize to a high degree.

The author points out several constructional differences between American and British types.

American stamps, both board drop and steam, are self-contained, i.e., are built entirely on their anvil blocks. The British drop stamp follows ordinary steam-hammer construction in having the anvil block and the supports carrying the lifting gear independent of one another. The requisite alignment of the anvil block and tup is secured by resting guides in the block, the upper ends of the guides being supported laterally by the framework carrying the lifting gear, and being free to move vertically. In this way fewer parts of the stamp are affected by the shock of the blow, and a rigid foundation can be used, making for greater efficiency of blow. It is common to place the block directly on the concrete bed, though it is better to interpose a layer of timber of moderate thickness.

American stamps are generally bedded on timber to a depth of several feet—a rather costly arrangement—an elastic foundation being necessary to soften the shock of the blows on the stamp framework, etc., which carried on and bolted direct to the block would otherwise suffer unduly. In the case of steam stamps, the piston rod is a vulnerable part, and excessive ridigity in the foundation would result in a very short life. Experience has shown that nothing but the best materials are admissible in this type of stamp, if frequent and costly stoppages are to be avoided. In the best American practice, nickel-chrome steel, specially treated, is used for piston rods and heavy bolts, the tup is of specially selected steel, and the frames steel castings.

In British stamps the guides for the tup are generally straight bars of steel, or iron or steel castings of simple form carrying single or multiple "vees" engaged with the tup. The bars rest in holes in the anvil block, and are suitably held in the upper framework, as already mentioned. The lower ends of the bars are generally wedge-shaped, the holes in the block being formed to correspond so that the bars can accommodate themselves to some extent in the event of the block settling unequally and getting tilted. This is a bad arrangement, because the bars jump under the blows and then getting loose momentarily can twist, with the result that the tup is thrown out of alignment with the block.

In American stamps the standards, fitted with adjustable slides for guiding the tup, are made as supports of ample proportions for carrying the cylinder or the headgear, and are spread out at the base and accurately fitted to the block, which is a much better arrangement.

The universal practice as regards the upper die is to dovetail and key it into the tup. In American stamps the same plan is adopted for the lower die. A strong steel die holder of ample area is dovetailed into the block, and the die is held by dovetailing in the holder. There are no ready means of altering the position of the dies in relation to one another, and reliance is placed on accurate sinking of the impressions to secure the correct registering.

The general practice among British stampers is to have poppets fitted to the anvil block and to hold the die between screws—usually four in number—working in the poppets and pointing radially. (In France and Belgium six poppets with screws on rectangular axes are favored.)

There is also a material difference in the stamping processes used in the two countries. In American practice preparing for preliminary forming as well as the stamping of the article is done as far as possible under the same stamp. The original British method is to employ a dummying or preparing stamp alongside the main stamp and to rough out the article under it between suitable tools arranged with narrow and wide bases by the ordinary forging process. A variant on this plan is to use fast-running steam or power hammers for preparing quite independently of the stamping, the pieces being forged in numbers and then taken away to be reheated for stamping. This is a considerable improvement on the older method, as the saving in time by using high-speed hammers more than compensates for the cost of reheating and a much larger output per stamp is obtained.

An interesting feature of the British methods is disclosed by the author when he calls attention to the fact that the use of forging machines for upsetting is unknown in England.

The conclusion to which the author comes is that the British practice needs overhauling. He calls attention, however, to the fact that if American stamps were installed, but no change of methods of working adopted, the full advantage of their construction would not be realized. On the other hand, it would not be feasible to work on American lines with British stamps as their construction is much too weak for this. (*The Engineer,* vol. 130, no. 3373, Aug. 20, 1920, pp. 173-174, *cA*)

Practical Suggestions on the Use of Twist Drills

The Use and Abuse of Twist Drills, H. Wills. Twist drills will stand more strain in proportion to their size than almost any other tool. The form of drill point is important because it controls the rate of production, accuracy of the hole, frequency of necessary grinding, and the life of the drill. Speed and feed are also of great importance.

When grinding the drill points the following rules should be observed:

Both cutting lips must be inclined at the same angle with the axis of the drill and must be of equal length. The point angle of 59 deg. has been universally adopted as best suited for average conditions.

The drill point must have the proper clearance or contour of surface back of the cutting edges and this clearance must be identical on both sides. Approximately a 12-deg. clearance angle combined with the center angle of 130 deg., which will give a constantly increasing clearance toward the center, has proven best for average conditions.

If the drill points are not properly ground a number of undesirable conditions will result.

An illustration in the original article shows how a gage can be used to determine approximately the center angle. Although the included angle of the gage is only 118 deg., a center angle of 130 deg. is recommended.

Twist drills are often made with a gradual increase in the thickness of the web about the shank, with the result that as the drill becomes short and the web thinner, greater force is required to drive it. To overcome this, it is good practice to thin the web by grinding away the excess thickness, reducing it to its original dimensions.

In grinding high-speed drills care should be taken not to overheat them, and when heated they should never be plunged into cold water.

As regards speeds and fits, tables are given in the original article for use on various commercial materials. If the drill is properly ground and the corners of the cutting lips begin to show rapid wear, it is an indication that the speed is too great. If the cutting edges roughen or break out in minute particles, it indicates that the feed is too great.

As regards very small drills, attention is called to the fact that they are very frequently run at an excessively low speed with the result that breakage is excessive. These are delicate tools. They must be run true and the cutting edges kept sharp. A fine-grade emery stone is best suited for this purpose. (*Iron Age,* vol. 106, no. 8, Aug. 19, 1920, pp. 461-463, 12 figs., *pA*)

MEASURING INSTRUMENTS

Electrical Apparatus for Registering Fuel Consumption on Motor Vehicles

The Bowden Petrometer. Description of a device acting electrically which registers the fuel consumption on a motor vehicle or aeroplane from moment to moment under all conditions.

As shown in Fig. 9, the petrometer consists essentially of a vessel divided more or less centrally by a diaphragm in which three passages are formed. One of these passages, on the left, is connected to the main supply pipe from the tank and can be closed by a needle valve; the second passage, connecting the upper and lower chambers, is opened and closed by another and larger valve. The third passage through the diaphragm, connected by a pipe to a central barrel, is set midway through the diaphragm and is equipped with two disks with a float chamber between them.

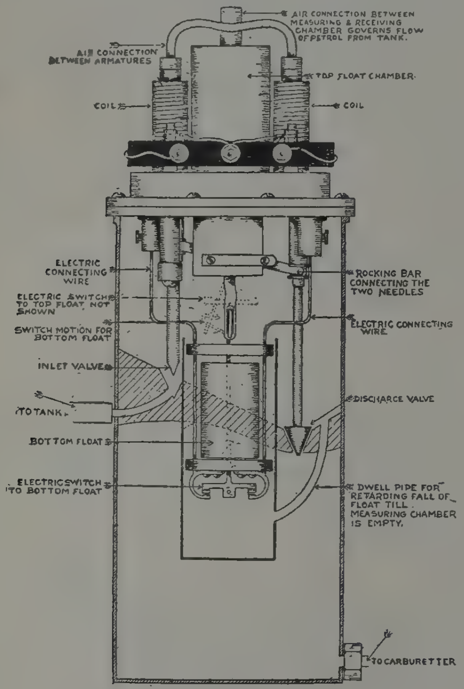

AIR CONNECTION BETWEEN MEASURING & RECEIVING CHAMBER GOVERNS FLOW OF PETROL FROM TANK.
AIR CONNECTION BETWEEN ARMATURES
TOP FLOAT CHAMBER.
COIL
COIL
ELECTRIC CONNECTING WIRE
ROCKING BAR CONNECTING THE TWO NEEDLES
ELECTRIC SWITCH TO TOP FLOAT NOT SHOWN
SWITCH MOTION FOR BOTTOM FLOAT
ELECTRIC CONNECTING WIRE
INLET VALVE
TO TANK.
DISCHARGE VALVE
BOTTOM FLOAT
ELECTRIC SWITCH TO BOTTOM FLOAT
DWELL PIPE FOR RETARDING FALL OF FLOAT TILL MEASURING CHAMBER IS EMPTY.
TO CARBURETTER

Fig. 9 The Bowden Petrometer for Measuring Fuel Consumption of a Motor-Vehicle Engine

Beneath the lower disk are two curved contact pieces, wired through this disk and the upper one—and rigidly, for constructional support—up to the terminals of the coils, which are mounted on a platform above, and outside the fluid-containing vessel, along with an upper float chamber, the armatures—not shown—that carry the needle valves, and the positive terminals from the source of electricity. Each float is mounted in a central spindle that carries a tungsten-tipped contact bar which makes or breaks the electric circuit for the upper or lower "loop," so to say, thus established, as it makes or leaves contact with the stationary contact pieces, making—in the case of the lower float chamber—only while it is empty, but breaking the moment the float lifts, when the lower, or measuring, chamber is full. The upper contact bar, on the contrary, makes contact from the moment the petrol is free to enter the upper or receiving chamber, and lift the upper float, and does not break contact until the upper float chamber is empty. The two needle valves are interconnected by a centrally pivoted rocking bar, which carried a free arm extending downward at a right angle to it, to engage a loop from the spindle of the lower float. The function of this arm and loop, so far as can be seen, would simply steady the fall of the lower float.

All that is apparent from the diagram is that during the "make" of the lower float contact bar, the left-hand coil is energized to lift the inlet needle valve beneath it, which remains lifted until the upper float chamber is sufficiently full from the reception of the petrol for the upper float to lift its contact bar into "make" contact; which action is simultaneous with the "break" of the lower contact bar from the lift of the float in the lower chamber by the entry of a certain amount of petrol through the free connecting or dwell pipe meanwhile. Then at the break of the latter, simultaneously with the make of the former, the left-hand coil is deënergized to drop its needle valve, while the right-hand coil is energized to lift the discharge valve into the measuring chamber, which, as the diagram shows, is in free connection with the carburetor.

The discharge valve is mechanically connected with the dial so that the moment it closes it registers the amount it has admitted into the lower or measuring chamber. The dial has two sets of hands—one, non-adjustable, registering the gross fuel consumption; and the other with a trip hand adjustable for the run consumption. In the lower float chamber there is also installed a damping disk, which, acting like a paddle in the constant amount of fluid renders the apparatus proof against jerking or oscillations, which is an important feature. (*Auto-Motor Journal,* vol. 25, no. 31/1021, pp. 799-800, 4 figs., *d*)

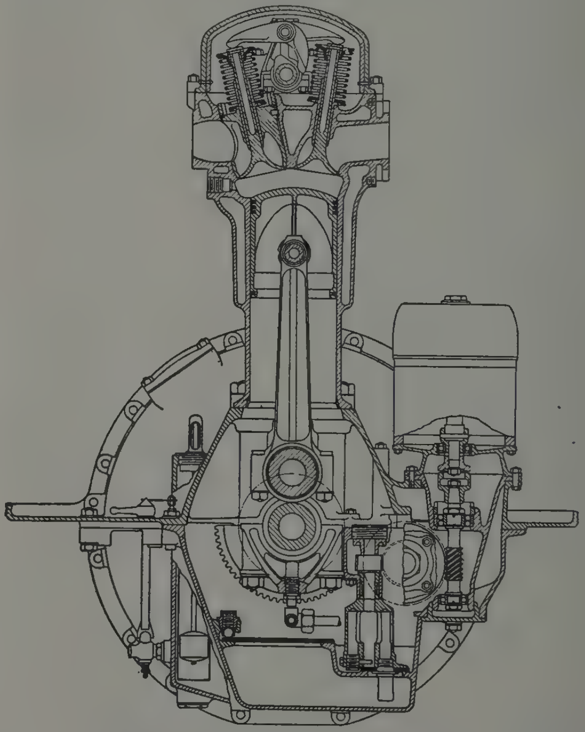


Fig. 10 Cross-Section of Engine on New 40-Hp. Lanchester Chassis

METALLURGY (See Engineering Materials)

MOTOR-CAR ENGINEERING

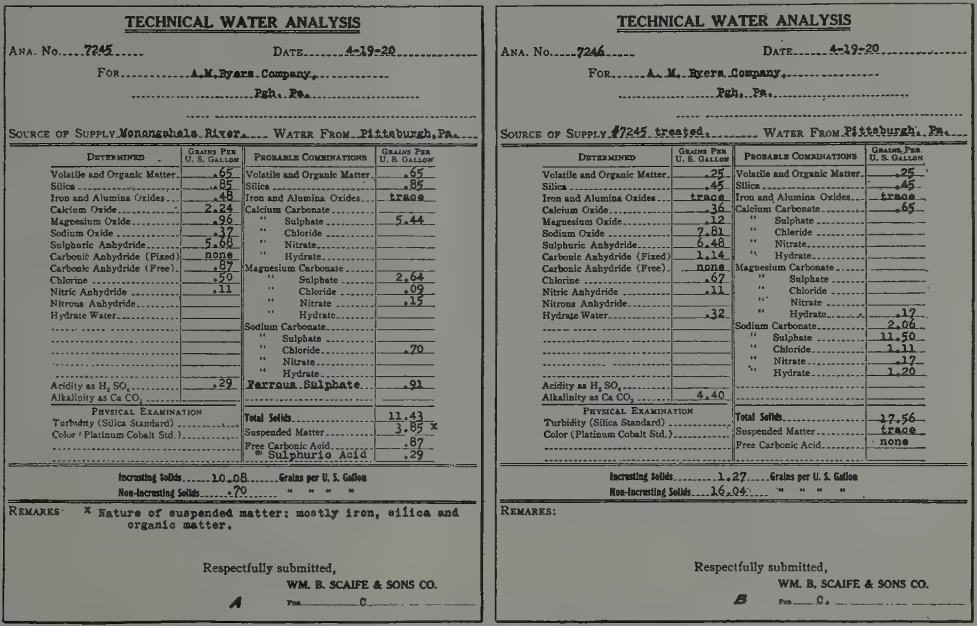
Lanchester Motor-Car Engine

40-Horsepower Lanchester Chassis. Description of the new Lanchester chassis of which the description of the engine is of particular interest.

The engine is 4-in. bore by 5-in. stroke and has a brake rating of 89 hp. at 2000 r. p. m. The cylinders are of cast iron and formed in two blocks of three cylinders. The inlet and exhaust ports in the integral cylinder head are so arranged that in each block two inlet and two exhaust valves have common ports, the remaining two valves having separate ports. The two cylinders nearest the carburetor in each block have a common port and the areas and length of the ports and pipes are so arranged that each cylinder obtains an equal amount of mixture.

Two spark plugs per cylinder are fitted in a horizontal position immediately beneath the inlet ports. The spark points are in pockets communicating by small drilled holes with the combustion space which is completely machined, and the spark-plug bosses are completely surrounded by water pockets.

As regards the question of valve seats, the inlet valves only are fitted in a detachable cage, while the exhaust valves are seated directly in the cylinder head. The exhaust valve can, however, be readily removed by dropping it on to the piston head and withdrawing it through the inlet port. Each valve cage is pressed against a taper formed in the cylinder head and held in position by a circular nut slotted for a special wrench, a snug preventing the cage from rotating while the nut is turned. Both inlet and exhaust valves are made from tungsten steel. The cross-section of the engine indicating the general arrangement is shown in Fig. 10. (*The Automobile Engineer,* vol. 11, no. 141, Aug. 1920, pp. 311-318, 20 figs., *d*)



TECHNICAL WATER ANALYSIS

Ana. No. 7245 Date 4-19-20

For A.M.Byers Company,
Pgh. Pa.

Source of Supply Monongahela River. Water From Pittsburgh,Pa.

Determined	Grains per U. S. Gallon	Probable Combinations	Grains per U. S. Gallon
Volatile and Organic Matter	.65	Volatile and Organic Matter	.65
Silica	.85	Silica	.85
Iron and Alumina Oxides	.48	Iron and Alumina Oxides	trace
Calcium Oxide	2.24	Calcium Carbonate	
Magnesium Oxide	.96	" Sulphate	5.44
Sodium Oxide	.37	" Chloride	
Sulphuric Anhydride	5.68	" Nitrate	
Carbonic Anhydride (Fixed)	none	" Hydrate	
Carbonic Anhydride (Free)	.87	Magnesium Carbonate	
Chlorine	.50	" Sulphate	2.64
Nitric Anhydride	.11	" Chloride	.09
Nitrous Anhydride		" Nitrate	.15
Hydrate Water		" Hydrate	
		Sodium Carbonate	
		" Sulphate	
		" Chloride	.70
		" Nitrate	
		" Hydrate	
Acidity as H_2SO_4	.29	Ferrous Sulphate	.91
Alkalinity as $CaCO_3$			
Physical Examination			
Turbidity (Silica Standard)		Total Solids	11.43
Color (Platinum Cobalt Std.)		Suspended Matter	3.85 x
		Free Carbonic Acid	.87
		" Sulphuric Acid	.29

Incrusting Solids 10.08 Grains per U. S. Gallon
Non-Incrusting Solids .70 " " " "

Remarks: x Nature of suspended matter: mostly iron, silica and organic matter.

Respectfully submitted,
WM. B. SCAIFE & SONS CO.
A
Per C.

TECHNICAL WATER ANALYSIS

Ana. No. 7246 Date 4-19-20

For A. M. Byers Company,
Pgh. Pa.

Source of Supply #7245 treated. Water From Pittsburgh, Pa.

Determined	Grains per U. S. Gallon	Probable Combinations	Grains per U. S. Gallon
Volatile and Organic Matter	.25	Volatile and Organic Matter	.25
Silica	.45	Silica	.45
Iron and Alumina Oxides	trace	Iron and Alumina Oxides	trace
Calcium Oxide	.36	Calcium Carbonate	.65
Magnesium Oxide	.12	" Sulphate	
Sodium Oxide	7.81	" Chloride	
Sulphuric Anhydride	6.48	" Nitrate	
Carbonic Anhydride (Fixed)	1.14	" Hydrate	
Carbonic Anhydride (Free)	none	Magnesium Carbonate	
Chlorine	.67	" Sulphate	
Nitric Anhydride	.11	" Chloride	
Nitrous Anhydride		" Nitrate	
Hydrate Water	.32	" Hydrate	.17
		Sodium Carbonate	2.06
		" Sulphate	11.50
		" Chloride	1.11
		" Nitrate	.17
		" Hydrate	1.20
Acidity as H_2SO_4			
Alkalinity as $CaCO_3$	4.40		
Physical Examination			
Turbidity (Silica Standard)		Total Solids	17.56
Color (Platinum Cobalt Std.)		Suspended Matter	trace
		Free Carbonic Acid	none

Incrusting Solids 1.27 Grains per U. S. Gallon
Non-Incrusting Solids 16.04 " " " "

Remarks:

Respectfully submitted,
WM. B. SCAIFE & SONS CO.
B
Per C.

Fig. 11 Water Analysis Before and After Treatment at Byers Plant

POWER-PLANT ENGINEERING

Water-Softening in Pittsburgh District. The condition existing in the Pittsburgh district with respect to boiler feedwater is that the liquid available for this use in its natural condition is not water but a changing solution of several scale-forming substances with a liberal percentage of free acid and undissolved organic matter. Under these conditions boiler troubles would be inevitable unless some means were taken to control the chemical constitution of feedwater. The present article describes the experience of, and methods developed for such control of feedwater by the plant of the A. M. Byers Company and at the mine and coke plant of W. J. Rainey at Allison.

At the Byers plant the water is taken directly from the Monongahela River and used as condensing water in jet condensers, so that it is delivered to the hot well at a temperature of about 70 deg. From the hot-well part of the water is used in hydraulic presses, while the remainder goes to the softening system where it is treated for boiler use.

This water is treated in an intermittent system. The process in the main consists in adding to the water as it enters the settling tank the proper chemicals which either precipitate the scale-forming impurities or change them into impurities that are of non-encrusting character, or both; and also neutralize the free acid content of the water. In the settling tanks, of which there are two (used alternately) the treated water is first stirred and then allowed to stand for two to six hours, depending upon the load being carried.

The reagents used are lime to take care of the bicarbonates and free acid; soda ash for permanent hardness and soluble lime salts; and ferrous sulphate in sugar form to act as a coagulant and facilitate settlement.

Because of the fact that the impurities in the water vary quite irregularly frequent testing becomes necessary. Fig. 11 shows the variation produced in the water by the treatment described above.

The water flows by gravity from the settling tanks, in this case located on the roof of the building, to the filters, the flow being controlled by a float-operated valve so that the filter bed is always covered but the condensers never overflow. Another float-operated valve prevents flow from the filter to the clear-water tank when it has become filled.

When the plant began using treated water the boilers were heavily encrusted with hard scale. Because of this, only a partial treatment was used to prevent the scale from coming down too rapidly and causing burned tubes. This treatment was gradually increased until the heating surfaces were free from scale. Previous to the introduction of water treatment continual trouble was experienced necessitating replacement of drums and tubes. During the six months that the treating plant has been in operation the tube replacements have been reduced to almost nothing and shutdowns on account of bad water have been entirely eliminated. (*Power Plant Engineering,* vol. 24, no. 16, Aug. 15, 1920, pp. 777-784, 16 figs., *d*)

STAMPING (See Machine Shop)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

A $30,000 Contribution for Coöperative Research

A VERY striking example of how coöperative research may work out in practice is shown by the recent contribution of $30,000 made by the General Electric Company to extend the investigations of the Committee on Fatigue Phenomena of Metals of the Division of Engineering of the National Research Council into the field of nickel steel. This work was originally planned to cover carbon steels only, and was heretofore supported by Engineering Foundation, which appropriated $30,000 for two years' work, and by the University of Illinois, which contributes the equivalent of about $12,000 in the services of Professor Moore and in space, heat, light and equipment.

Although fatigue failure of metal parts subjected to rapidly alternating stresses has been recognized for many years, the recent era of high speeds has yielded cases of great number and importance—in connection with steam-turbine shafts and rotors, airplane-engine crankshafts, the hulls of steel ships, axles and shafts in railway cars, motor cars and trucks, and other machine parts. Such metal parts occasionally fail under ordinary service conditions without showing any general distortion or other symptoms, even when the material is known to be highly ductile. These failures are found only in parts subjected to alternations of stress repeated in some cases millions of times, and therefore are attributed to fatigue of the metal.

Recognizing the value of the results of these investigations to the industries of the country, Engineering Foundation Board about a year ago made a grant of $15,000 a year for a period of two years for the investigation of fatigue phenomena in carbon steels, under a Committee of the Division of Engineering of the National Research Council. Articles of agreement were drawn up between the National Research Council, Engineering Foundation and the University of Illinois whereby the experimental work was to be done at the University of Illinois under the direct supervision of Prof. H. F. Moore, Chairman of the Committee. In addition to the services of Professor Moore, the University furnishes the necessary space and facilities for conducting the work to the best advantage.

Prof. J. B. Kommers, of the University of Wisconsin, a specialist in this subject, has secured a two-year leave of absence and is devoting his full time to the work together with a staff of assistants. The apparatus is all installed and the work progressing according to schedule.

The General Electric Company has recently signed an agreement with Engineering Foundation, National Research Council and the University of Illinois, whereby it agrees to contribute the additional sum of $30,000 to extend the work to include 3 per cent and 3½ per cent nickel steel. This extension is to be considered part of the original program and no restriction is placed by the General Electric Company on the publication of the results.

Although the results of this work on nickel steels will be of immediate commercial value to the General Electric Company, they will also be of value to other manufacturers. The attitude of the company is therefore an unusually broad-minded one. On the other hand, great economies will result from the coöperation agreed to. This is easily appreciated when one considers that the facilities, the supervising experts, and much of the apparatus for conducting these tests are already available and that the consulting services of a group of the foremost experts in the country are furnished without cost, the chief additional cost being some additional apparatus and junior assistants.

Moreover, the coöperative method with its concentration of talent makes much more likely the discovery of the fundamental laws of fatigue, which will be vastly more valuable than the mere empirical information as to the fatigue limits of two varieties of steel.

Thus the broad-gage, far-sighted policy of the General Electric Company demonstrates the commercial feasibility of coöperative research in the fundamentals of engineering, and opens up a large field of usefulness to the National Research Council and Engineering Foundation. It is also an illustration of the large cumulative returns likely to accrue from a wisely placed investment such as that made by the Engineering Foundation Board, which gave the necessary initial impetus to this movement.

Fuel for Motor Transport

The Fuel Research Board of the Department of Scientific and Industrial Research has prepared an interim memorandum on fuel for motor transport. The memorandum deals chiefly with the possibility of substituting alcohol for petrol and consists of three sections: (*a*) Historical, (*b*) The Present Position of Power Alcohol and (*c*) Alternate Motor Fuels. Copies (at 3d) may be obtained through any bookseller in England or from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2.

Research Laboratories in Industrial Establishments of the United States

The Bulletin of the National Research Council for March, 1920, is devoted to a description of the research laboratories in industrial establishments of the United States compiled by Alfred D. Flinn, assisted by A. J. Porskievies and Ruth Cobb. The list contains the names of over 300 industrial establishments with research laboratories and gives the work done by the laboratories, the research staff, the equipment and the principal product of the company. This Bulletin will be of value to those requiring research work. The Bulletin is published by the National Research Council of the National Academy of Sciences, Washington, D. C., with publication office at 1201 16th St.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulae or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Air A1-20 Operation of Blowers in Parallel. Tests were conducted using two motor-driven fans of the single-width, multivane type with double inlet and forward-tipped vanes. Characteristics were obtained for parallel operation at different speeds discharging air against the same head. Certain negative characteristics were determined. The relative advantages of flat and steep characteristic types of forced-draft blowers are discussed. Work was done at the Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Apparatus and Instruments A11-20 Gas Analysis. Indicators for carbon dioxide and oxygen in air and flue gas by L. H. Milligan, D. O. Crites and W. S. Wilson are discussed in Technical Paper 238 of the Bureau of Mines. This paper shows the form of apparatus developed by the Bureau of Mines for determining carbon dioxide in large and small quantities. The apparatus is not quite similar in form to other apparatus used for this purpose. Address F. G. Cottrell, Director, Bureau of Mines, Washington, D. C.

Cement and Other Building Materials A10-20 Aged Cements in Concrete Mixtures. Cement which had been in storage for a year and a half has been tested after lumps had been removed by sieving. Concrete made with the old cement after sieving was compared with that made with new cement and it was found that a 1:1¼:2½ mix of old cement gave concrete equal to that of a 1:2:4 mix with new cement. Similar tests were conducted at Vicksburg, Miss., by the U. S. Engineers' Office. These results show that a 1:2¼:4½ mix of aged cement is equal to a 1:3:6

mix of fresh cement. Reference is also made to *Cement and Other Building Materials A7-20*, found in the September number of MECHANICAL ENGINEERING. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemistry, Inorganic A1-20 Manufacture of Hydrogen. The U. S. Naval Engineering Experiment Station at Annapolis, Md., has reported on an investigation of the possibilities of manufacturing hydrogen gas from carbocoal and steam. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Electric Power A4-20 Brake and Stray-Power Methods of Testing Motors. The U. S. Naval Engineering Experiment Station at Annapolis, Md., has reported on a test of comparison of brake and stray-power methods of testing variable-speed motors. Certain losses are not included in stray-power measurement and these tests show that losses amounting to from 1½ to 3 per cent are not determined by the stray-power method. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Foods A1-20 Food Investigating Board of Great Britain. Special Report No. 1 on Design of Railway Wagons, price 4d. Report No. 2 on The Literature of Refrigeration, price 5d. Address H. M. Stationery Office, Imperial House, Kingsway, London, WC2.

Fuel Utilization and Appliances A1-20 Gas Appliances. The Bureau of Standards has made a report on the work of the year in coöperation with the Industrial Fuel Committee of the American Gas Association. The proper design of air shutter, gas orifice and burner throat has been worked out and apparatus has been perfected for measuring the air and gas. The results show that many appliances used at present are low in efficiency and great improvement can readily be made. Some equipment uses only 10 to 30 per cent of the heat of the gas and can be made to yield 30 to 50 per cent. Investigations show that burners can be designed to operate natural gas at low pressure for use in the winter season and that the installation of regulators to supply gas at a low and uniform pressure at all times would result in savings. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Glass and Ceramics A1-20 Transverse Strength of Fireclay Tile. Fireclay tile subject to temperature of 1350 deg. cent. has been tested to determine modulus of rupture and deformation. Many of these tile cannot support any appreciable load beyond their own weight at this temperature. If loads are to be carried the investigation points to the need of entirely different compositions and combinations of clay and grog. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mining, General A3-20 Output from Coal Miner. Report 2145 by W. W. Adams shows that the output per miner in the U. S. is greater than that in other countries. The amount has increased from 3.37 tons per day in 1901 to 4.40 tons in 1918. New South Wales 4.07 tons per day in 1917, Nova Scotia 3.35 tons per day. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Refrigeration A2-20 Food Investigating Board of Great Britain. Special Report No. 1 on Design of Railway Wagons, price 4d. Report No. 2 on the Literature of Refrigeration, price 5d. Address H. M. Stationery Office, Imperial House, Kingsway, London, WC2.

Sound A1-20 Submarine Sound Research Work. The U. S. Naval Engineering Experiment Station at Annapolis, Md., has completed for the navy sound research work of the following nature:

(*a*) Determination of relative efficiency of sound-signaling receiving devices with regard to sensitivity
(*b*) Determination of relative efficiency of four types of installation with regard to directivity
(*c*) Depth sounding with listening devices
(*d*) Comparison of German and United States oscillators
(*e*) Interfleet communication using listening devices and oscillator
(*f*) Investigation of screening effect of hull of vessel upon transmission and reception of sound waves
(*g*) Determination of relative sensitivity and directive qualities of MV electrical blister installation for submarines
(*h*) Skin installation of MV microphone receiving lines
(*i*) Investigation of sound apparatus for battleships
(*j*) Development of range finder
(*k*) Sound reception in deep water.

Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Steam Power A1-20 Flow of Steam. The U. S. Naval Engineering Experiment Station has reported a résumé on the flow of steam through pipes and fittings to the Bureau of Steam Engineering of the U. S. Navy. See August, 1920, number of *Journal A. S. N. E.*

Water, Sewage and Sanitation A3-20 Water Supply and Sewage Disposal for Country Houses. No. 21 of the Engineering Experiment Station Series of the University of Missouri is devoted to the water supply and sewage disposal for country homes by E. J. McCaustland, Director. This Bulletin of 36 pages gives construction, drawings and diagrams for the installation of systems of water supply and sewage disposal for country homes. Address E. J. McCaustland, Director, Engineering Experiment Station, Columbia, Mo.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Cement and Other Building Materials B3-20 Preserving Coatings for Stone. The Bureau of Standards is investigating a colorless surface treatment for stone for the prevention of disintegration by weathering. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke B4-20 Oil Shales. An investigation of the fundamentals of oil-shale retorting is being carried out by the Bureau of Mines. A report No. 2141, by M. J. Gavin, has been made to the Bureau on the plan of this work. In June a report was made by the same author on oil shales and their economic importance. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Glass and Ceramics B2-20 Glass Industry. The Bureau of Standards is endeavoring to develop an improved refractory for the construction of pots for glass making, with particular reference to corrosion. A systematic study is being made of bodies composed of silicious bond clays mixed with aluminous grog and aluminous bond with silicious grog. Crucibles of these mixtures will be fired and then subjected to the action of corrosive barium glass. On breaking the crucibles the depth of penetration will determine the value of the mixture. The transverse strength of the mixture in the dry and fired state, as well as its shrinkage, will be determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B9-20 Bearing Alloys. The tests of babbitt bearing alloys at elevated temperatures have shown that the yield point and ultimate strength decrease rapidly with increasing temperatures. Babbitts containing lead lose their strength more rapidly than those with a tin base. Brinell hardness measurements are being made. Varying quantities of tin are being added to high-grade tin-base babbitt to study the physical properties. A thermostatically controlled air bath is being used for annealing specimens over long periods of time. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B10-20 Microstructural Change on Tempering Steel. Elaborate series of examinations to determine changes in structure of hardened steels upon tempering has been started at the Bureau of Standards. Magnetic tests and density determinations have indicated pronounced changes. Six different types of steel are being used with carbon content varying from 0.07 per cent to more than 1 per cent. The steel will be hardened by quenching in water from various temperatures, and the length of time at which the material is held at the quenching heat will also be considered. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B11-20 Materials Investigations. The U. S. Naval Engineering Experiment Station is at work on investigations of failures in shafting, boiler parts and condenser tubes and on new metals and alloys. The work is to determine cause of failure or to obtain data for the revision of specifications. The Bureau is also at work on investigations of impact, resistance and endurance properties of metals. It is also performing experimental work for the Joint Committee on Investigation of the Effect of Phosphorus and Sulphur in Steel. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Steam Power B3-20 Boiler Water. The U. S. Naval Engineering Experiment Station is investigating the treatment of boiler water by the use of aluminous plates. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Heat C1-20 Heat Transmission to Air at High Pressures. Experimental information regarding the coefficient of heat transfer through steel from gas to compressed air under pressures ranging from 300 to 3000 lb. per sq. in., with a temperature range from —10 deg. fahr. to 60 deg. fahr. is desired. Address W. S. Aldrich, American Bridge Company, Master Mechanics Department, Gary, Ind.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

E—RESEARCH PERSONNEL

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Fuels, Gas, Tar and Coke F6-20 Coal Storage. Technical Paper 235 on Safe Storage of Coal, by H. H. Stoek, gives instructions for storage and includes bibliography of technical papers on this subject, published by the Bureau of Mines, the Engineering Experiment Station of the University of Illinois and articles published in technical journals. Bureau of Mines, Washington, D. C. Address F. G. Cottrell.

Machine Tools F1-20 Metal-Cutting Tools. A bibliography of five pages on metal-cutting tools from 1918 to June 1920. Search 3061. This supplements *Machine Tools F1-19* from 1903 to 1918. Search 2546. Address A.S.M.E., 29 West 39th St., New York.

Petroleum, Asphalt and Wood Products F5-20 Recent Articles on Petroleum, and Allied Substances. The Bureau of Mines receives monthly reports on the above subject by E. H. Burroughs, Editorial Assistant. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A. S. M. E. affairs.

Making the New Federation a Success

TO THE EDITOR:

A new machine has been designed, called a "Federation," to enable the engineering profession to act unitedly on matters of public welfare in which the profession as a whole is interested. In the September issue of MECHANICAL ENGINEERING Mr. Morris Llewellyn Cooke finds fault with the design of this machine, which he declares to be "short-sighted almost to the point of insuring failure." He gives as his reason that the Constitution of the new Federation permits the governing boards of the Societies to elect the representatives to the new American Engineering Council instead of having them elected by popular vote of the membership.

But is this distinction, after all, such a very important one? A great many good people labored long and diligently a few years ago to reform the United States Senate. They secured a Constitutional amendment requiring the Senators to be elected by popular vote instead of by the State Legislatures; but does Mr. Cooke think any large improvement has resulted in our Senate? Is it not a fact that representative government sometimes works better than purely democratic methods? What percentage of this Society's members would really take an active interest in the selection of the Society's representatives on the new American Engineering Council?

And whether Mr. Cooke and other critics of the Federation are right or wrong is not important now, *for the time to criticise has passed.* If the profession wants machinery by which it can speak with a united voice on public questions, then the only thing to do is to go in whole-heartedly and make the new Federation a going concern. If the machine proves defective here and there (and it probably will, for few new machines come from the designer perfect), then alter it as experience and wisdom accumulate.

Let us remember the great amount of energy and ability that has been devoted to planning this Federation. If the results of all this work are to be discarded by the profession, it is unthinkable that another set of men would begin over again the toilsome task of harmonizing differences of opinion and evolving a plan in which all existing societies of engineers could coöperate.

The only thing to do, then, for every engineer who believes in coöperative action by the whole profession, is to "boost" the Federation, and find how it may achieve the largest measure of success. Let us remember, too, that success is always a relative term. Many engineers will have "mighty purposes" in mind, such as Mr. Cooke alludes to, which the new organization will probably be unable to effect. The experience of the present Engineering Council has shown that there are very real limitations on the work *any* such body can do. There is, however, plenty of work within its powers awaiting the new Federation, and it can succeed if the profession will give it the necessary backing.

CHARLES WHITING BAKER.

30 Church Street,
New York, N. Y.

A Word of Caution Regarding the Federation

TO THE EDITOR:

To those of us who went through the harrowing days at the beginning of our participation in the war of 1917, there can be no doubt of the value of an organization harnessing together, for the national security, development and welfare, all those engineering activities which lie at the very foundation of our industrial strength in every line.

I believe I can give no clearer indication of the national need in emergency than to say that within one year after our entry into the war there had been coördinated under the direction of the Council of National Defense, with whose Advisory Commission I had the honor to serve as a member, more than 144,000 distinct organizations of various kinds throughout the United States.

One strong word of caution I should, however, like to voice. We should endeavor at every point to make The Federated American Engineering Societies a truly practical and workable agency for definite accomplishment. We should avoid the pyramiding of new engineering activities, committees, boards, etc., which are so apt to come into being for the furtherance of localized and sometimes selfish interests of individuals or societies and which tend to still further confuse a sufficiently complicated situation. The activities of many of our society members of The Federated American Engineering Societies already overlap, and as these societies endeavor to develop and extend their prerogatives we may naturally expect further complications in authority and in duplication of work.

We have in The Federated American Engineering Societies a coördinating influence which can be made of inestimable practical value, both to its member organizations and to the departments in Washington. Let us see to it, therefore, that this new coördinating body is made to efficiently fulfill those objects for which it has been created.

Howard E. Coffin.

Detroit, Mich.

Comments on the Proposed Code of Ethics

To the Editor:

The writer is of the opinion that any attempt at a Code of Ethics to be adopted by The American Society of Mechanical Engineers, or by the engineering profession in general, is of doubtful value. He feels, however, that if we are to take such a step, it is worth while to contribute any comment that may aid in putting this in the best shape possible. The form of the report lends itself to a classification under three items, and the writer suggests that the numbered paragraphs be rearranged in accordance with this classification.

The engineer's relation to his own self-respect and to contact with the general public is considered in Pars. 1, 2, 3, 4, 9, and 11, and partly in Par. 12. The engineer's relation to his client or employer is considered in Pars. 5, 6, 7, and 10.

The engineer's relation to his fellow-engineers is considered in Pars. 8, part of 12, 13, and 14. The first three of these have to do with competition for employment.

In his relations to his own self-respect and to the general public, the first four paragraphs are noble and beautiful principles in which we all believe. They are, however, statements of such general character that it would be practically impossible to take any steps for discipline or enforcement regarding them unless the acts involved were so far contrary to all standards that the offender would be expelled from the Society whether there were any formal code of ethics or not.

The subject of reports and expert testimony—Par. 9—is undoubtedly a thing which we will all approve as stated. The writer would wish to state this even more forcibly; that is, that all reports and expert testimony should be given from a judicial standpoint, seeking the truth by including all facts and sound engineering principles. There should be no partisan bias leading to the omission of facts or the distortion of principles in order to reach the desired conclusion. The writer is very doubtful whether it is at all possible to enforce any such ethical principle by action of the Society's authorities on professional conduct.

The writer concurs in the statement in Par. 11 that we should avoid sensational, exaggerated or unwarranted statements about engineering work; but he takes exception to the second sentence of the paragraph to the effect that first descriptions of new inventions, processes, etc., for publication should be furnished only to the technical societies or to the technical press. He would prefer to see it stated that first descriptions, etc., should *preferably* be furnished to the engineering societies or to the technical press. He does not believe that this paragraph should prohibit the first appearance of any proper description in the general press when the engineer concerned finds that advisable.

The writer would prefer to see Par. 12 divided; one paragraph being that, "He should not advertise in an undignified, sensational, or misleading manner." The remainder of the present Par. 12 will be discussed in the comments referring to the engineer's relations with his fellow-engineers.

The statements of the engineer's relations with his clients or employers in Pars. 5, 6, 7, and 10 are all approved. These all register with one ethical principle: namely, that the engineer is not justified in any surreptitious action affecting the relation between himself and his client or employer which would not be approved by them if they were aware of such action.

The engineer's relations with his fellow-engineers when competing with them for business or employment, Par. 8, and parts of Pars. 12 and 13, are more open to question. These set up standards which, if conformed to by the more careful, conscientious members of the profession, would place them at a disadvantage with a considerable percentage of the profession who are not so scrupulous. As stated, they would be very difficult of enforcement. There is at the present time an effort to establish minimum rates for certain classified positions. It would be entirely proper to forbid engineers from seeking such positions at less than the minimum rates in cases where such have been established. We will all agree that no engineer should improperly solicit professional work, but there is likely to be a wide diversity of opinion as to what is and what is not improper.

Everybody will approve Par. 14, regarding engineers assisting each other by exchange of information and experience. This, of course, is ideal. I believe we already approximate to this to a considerable degree. It is not, however, a principle which any authority could be expected to enforce against any individual who was unwilling to conform.

C. M. Spalding.

Erie, Pa.

To the Editor:

The Code of Ethics published in your September issue of Mechanical Engineering is short, general in scope and positive. Furthermore, it has "teeth," for the Committee of Professional Conduct will have very wide powers. The Code of Ethics Committee's report, therefore, meets the recommendation of the Committee on Aims and Organization:

> That it is the sense of this Committee that a short Code of Ethics of broad scope, general in character, and positive rather than negative injunction be prepared and that the same be vigorously enforced.

Some have asked the Committee for more detailed clauses. A book could easily be filled if any attempt were made to be specific in every case. The Committee has therefore felt that the Code should be confined to a few broad, underlying statements, leaving matters of interpretation and elaboration to the "Committee on Professional Practice," whose findings will receive full publicity in our publications.

Others have asked why a Code is necessary. They say that the Committee's recommendations state only principles that engineers have recognized as just and honorable even from school days. All of which is quite true of practically our whole membership, and yet cases have already been presented informally to your Committee for consideration where engineers of high standing have been in doubt over certain conditions that confronted them in practice. The Code will be particularly helpful to our younger members, who are often more in need of such guidance. In fact, every new member entering the Society should be furnished with a copy of the Code. The Committee on Professional Practice will also act in an advisory capacity to those in doubt on the ethics of certain proceedings.

Still other members have intimated that it is proposed to enforce laws and police duties on our Society. In the Committee's mind these are merely incidents connected with the larger problem, viz., the elevation of engineering to its proper place as one of the most honorable and most respected professions. How can this be attained? We believe that the only sure method is to set up high standards of conduct that will win the respect and confidence of the general public as well as of our own associates and as a Society to see that these standards are rightly upheld. When these conditions prevail, membership in our Society will be an honorable distinction.

Our members will enjoy a well-earned confidence and as men of justice will be sought after for public service which will enable them to render best service as citizens.

But your Committee does not want this code confined only to the mechanical engineers. We hope to establish a joint code and practice in which electrical, civil, mining and chemical engineers can coöperate to the one end, that of adding an honorable distinction and true professional character to engineering.

The Committee proposes to render a final report at the Annual Meeting in December which will contain a few minor changes from the preliminary code. In the meantime, the Committee urges the careful consideration of our first report by every member and will welcome the widest discussion of this most important subject.

A. G. Christie,
Chairman Code of Ethics Committee.

Baltimore, Md.

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Extending Ocean Navigation to the Great Lakes

CHARLES WHITING BAKER

TO make the St. Lawrence River navigable so that ocean vessels may reach the Great Lakes, and to develop the water power of the St. Lawrence Rapids, as described by Mr. H. C. Gardner in the last issue of MECHANICAL ENGINEERING, is without doubt by far the most important engineering enterprise now proposed in the world. Indeed, one may well go further and say that this enterprise promises to yield a larger public benefit in proportion to its cost than any engineering work of the first magnitude ever undertaken.

This statement may be criticised on the ground that only very general estimates of the work are as yet available. Enough is known, however, to fully warrant the above claim.

Perhaps a statement of some of the arguments for the St. Lawrence project, in addition to those made by Mr. Gardner, may make still clearer its value and importance.

The economics of transportation have been revolutionized in the past half century, in that *terminal expenses,* and not the cost of hauling between terminals, have become the controlling factor. This is well illustrated, indeed, by some of the figures quoted by Mr. Gardner; but it is a fact which few, even among engineers, thoroughly comprehend.

The great advanage of the St. Lawrence Route is that it would eliminate entirely the enormous terminal expenses in the congested terminals on the Atlantic Seaboard. On traffic moved between the Lake cities and foreign ports, a cargo of dressed beef at Chicago, or steel plates at Cleveland, or wheat at Duluth or Fort William, could be loaded directly on an ocean steamer, whose holds need not be opened until the steamer docked at Liverpool or other foreign port. Contrast this with the present cost of transfer between railway car and steamer at an Atlantic port, and the great saving by the St. Lawrence Route begins to be evident.

Another matter not mentioned by Mr. Gardner is that the great fleet of Lake vessels, which are now kept idle by the winter ice blockade for nearly half the year, could go down to the sea every fall and take part in the world's carrying trade during the winter months. Of course, a compromise type of vessel, fitted to navigate both the Lakes and the Ocean, would have to be evolved; but that would come about naturally. The United States is destined to become the great coal supply depot of the world. Vessels adapted to the Lake Superior ore trade could also handle to advantage coal to South America and Europe during the winter months.

But it may be asked, if the St. Lawrence project offers the greatest opportunity for profit in the world, why has it not long ago been undertaken? There are many reasons, but the controlling one is this: the profits from the creation of the St. Lawrence Route will go to the public. It is not an enterprise that can possibly be undertaken by private capital to make money. Had this been possible, it would long ago have been completed. Where public welfare is concerned, however, one finds few willing to give the time and energy required to carry an enterprise from the stage of a mere project to practical success.

Further than this, in order to carry out the St. Lawrence project, at least four Governmental bodies must grant consent or take an active part, viz.: the Governments of the United States and of the State of New York, and those of the Dominion of Canada and the Province of Ontario. The various private interests which have reason to oppose the St. Lawrence Route have found it easy, through one or the other of these Governmenal organizations, to hinder united action.

The reason why the St. Lawrence project has at last reached a stage where there is promise that it may become a reality, is because an organization has been effected under which fourteen States of the Northwest have united in a league to promote this project, and are doing it officially through their State Governments.

If this organization continues and the work of promotion, public education, and planning the details of the enterprise is carried on with the same energy and ability that would be the case if the project were being furthered as a private enterprise by a powerful financial syndicate, then the success of the project appears certain.

CHARLES WHITING BAKER.

A Great Work Possible in Industrial Education

As recorded in Section Two of this number, a meeting was recently held of the Committee on Education and Training of The American Society of Mechanical Engineers, at which there was a discussion of more than ordinary importance by a number of eminent authorities who are well-informed on the agencies now existing in the United States for all kinds of industrial training.

This movement for industrial training has taken on a surprising and broad development within recent years and many of the larger corporations already have schools for their men. The Federal Government, the separate states and private firms have made efforts to solve the problem of production by the better training of men to enter the fields of industry and transportation. The Vocational Board in Washington and the National Metal Trades Association have been working systematically towards this end.

At the committee meeting a statement was made of the methods followed by different types of schools, after which the question was raised as to the duty and opportunity of The American Society of Mechanical Engineers in this direction. Its members are well equipped by training and experience to lend a hand. Many of them are already doing this. The constitution of the Society defines its object as the "promotion of the arts and sciences connected with engineering and mechanical construction." It is clear from this that the Society would be entirely within its intended scope and would be building on a firm foundation by taking an active part in the subject of industrial education, which is of such importance to the country.

It is obvious that the Society cannot undertake the instruction of young men for the profession and for the industries, but it *can* assist all the agencies of the United States toward a better understanding of the entire subject and toward greater coöperation. The smaller industries are in real need of information about the training of their men. If the Society should do nothing else than get out a report informing its members of the practice in different types of schools, including those within corporations, it would be contributing a useful work.

It is a year of opportunity in this country and The American Society of Mechanical Engineers ought to assist with all its might toward safeguarding against a lapse into the kind of barbarism masquerading under the name of Bolshevism. We do not belong to a profession confined solely to the technicalities of engineering, for the world has changed and we are part of the vast industrial system in which we must take our part. Hence a committee that will enable the Council of the Society to decide wisely upon the best method of serving the educational interests of the people can do as much for the future of engineering as the Boiler Code Committee is now doing, and that is a great deal.

Ira N. Hollis.

John R. Freeman Addresses Civil Engineers on Engineering Conditions in Japan and China

On the evening of September 15 Past-President John R. Freeman gave an illustrated talk before the members of the American Society of Civil Engineers and invited guests. The subject of Mr. Freeman's talk was Recent Engineering Developments in the Far East as noted during his eight months' sojourn in the Orient. The opening slides were devoted to manufacturing conditions in Japan, and included several pictures of modern factories engaged in the manufacture of electric lamps where the operators, under clean, light, healthy surroundings, worked at the very low wage of from 12 to 20 cents a day. Mr. Freeman felt that his welcome in Japan was sincere and that Americans, generally, were made to feel very much at home there.

Pictures relating to his visit to China covered the hydraulic bore at Hangchow, where a wall of water 15 ft. in height rushes up the bay at the equinoctial tidal season. Mr. Freeman also showed extensive views of the canal system of China, upon which the Chinese delta is dependent almost entirely for its transportation of food and cotton. The canals of China are examples of great engineering skill on the part of the Chinese, some of the masonry walls and locks having been built over 700 years ago and subject to frosts and torrents of destructive power. The bridges over the canals were constructed with great skill and true artistic appreciation.

Mr. Freeman is preparing a report on the proper procedure for removing the possibility of overflow of the Yellow River, which has caused immense loss of life during its flood periods by destroying the transportation system with consequent starvation. He made an extended trip through the Yellow River basin and had surveys of the country and studies of the old records of rainfall and flood channels placed at his disposal in this work. An interesting fact is shown in that the present channel of the Yellow River is located on a ridge, so that the upper normal level of the water is about 15 ft. above that of the surrounding country. The water is held in its course by dikes four or five miles apart, but which are incorrectly placed. These dikes require constant attention, and the Chinese local governments must be ready at all times to make the needed repairs. The water contains about 10 per cent silt by weight, which fills the bed rapidly and makes frequent cleanings necessary. This work is done by coolies, who remove the sediment into baskets at a cost of not more than 10 cents per cubic yard. Great mountains of silt were shown along the channel of the Yellow River. An interesting phenomenon of this river is its tendency to dig a deeper channel at high flood. Mr. Freeman is of the opinion that this tendency may be utilized in safeguarding the country against further floods.

Development of the Labor Situation in Australia

In general, it may be said that in no country in the world is the welfare of the worker hedged about by more legal safeguards than in Australia. In several states of the Commonwealth of Australia liberal provision is made for workers killed or injured in industrial disputes, old age and invalid pensions are paid, and minimum wages based on statistically-arrived-at cost of living are decreed by courts and boards for the settlement of industrial disputes and strikes.

In the July issue of the *Monthly Labor Review*, published by the Bureau of Labor Statistics in the U. S. Department of Labor, a summary of a report prepared by Trade Commissioner A. W. Ferrin of Melbourne, Australia, is included. This summary explains the development and growth of trade unions in Australia, starting with the increase of population in the cities caused by the influx of immigrants upon the discovery of gold in 1851. The building trade and printing trade unions were those first formed and were followed shortly by the stone masons. Unionism made rapid progress until, in 1919, the membership in trade unions was estimated at 580,000.

Two systems, based upon different principles, are in operation in Australia for the regulation of wages, hours, and general conditions of labor. The "wages board" system, prevailing in Victoria and Tasmania, has as its chief aim the prevention of disputes by the regulation of wages, hours, etc., by a special board appointed for a specific industry on application; while under the "industrial arbitration court" system, prevailing in Western Australia, an industry does not ordinarily come under review until after a dispute has actually arisen. New South Wales, Queensland, and South Australia have both systems.

The "wages board" system calls for the appointment by the Minister of Labor of a special board for a certain industry upon the request of employees or employers in that industry. An order is then issued, constituting a board of not less than four or more than ten selected by the Minister from nominations in the daily press. The constituted board elects a chairman, who votes only in case of a tie. The decisions of the board are submitted to the Minister for approval, and the employers and employees may appeal from the board's decision to a court composed of a judge of the supreme court of the State, appointed for a fixed period, and one representative each of the employers and employees, appointed for the duration of the case in review. The decision of this court is final.

Since under the industrial arbitration court system industries do not come under review until a dispute has arisen, it is quite feasible for the two systems to work together as they do in New South Wales, Queensland, and South Australia. Where wages boards are unable to settle satisfactorily the conditions in a given industry, either side can appeal to the industrial arbitration court and all agreements which have been reached by conferences between employers and employees can be registered with the court, thus acquiring the standing of court awards.

In spite of penalties against breaches of award, striking and locking out, strikes are very numerous. From 1913 through 1918 there have been 2152 disputes affecting 7697 plants, causing a loss of 8,756,389 working days, with a loss of £5,073,346. In 1919 the seamen's strike, causing an estimated loss of wages of £3,000,000, tied up industries in Victoria dependent upon coal from New South Wales. The marine engineers' strike, lasting for three months, ending Feb. 25, 1920, threw 15,000 persons out of work with a wage loss of £1,000,000. A strike of miners at Broken Hill, beginning in May 1919, is still in force. This strike is interesting in the manner in which it has been financed. Strikers understanding various trades, such as cobbling or barbering, contribute their services, the supplies being furnished out of a general fund which is made up of contributions from unions and individuals.

Another feature of Australia's labor disputes is the "go-slow" policy, or "lazy strike," which reduces output to a minimum, with the idea of forcing concessions from capital. It has been adopted with much effect in the Government dockyards, where the riveters reduced their average of rivets to 73 per day per man against a normal of 273, and by telephone operators, who refused to answer more than a given number of calls per day.

In general, it may be said that neither capital nor labor finds the existing legislation for the avoidance and settlement of industrial disputes in Australia satisfactory. Labor is dissatisfied with the wage-board system because it fixes wages for a period, before the completion of which the rapid advance in the cost of living has made the award inadequate; and with arbitration because it believes that more can be obtained by direct action than by resorting to courts. Capital objects to both systems because of the difficulty of inducing labor to abide by awards and the belief that the boards and courts are too radical.

Commercial interests in Australia have expressed the desire that a new system be established whereby the employers and employees can meet on friendly terms and come to a proper understanding of each other's difficulties. In line with this idea, a royal commission has been appointed, sitting at Melbourne, to consider the subject of industrial unrest and to fix, if possible, a basic wage for the whole Commonwealth.

James Hartness To Be the Next Governor of Vermont

James Hartness, Past-President, The American Society of Mechanical Engineers, who has been a candidate for the Republican nomination for Governor of Vermont, won a sweeping victory at the primaries held on September 14. Mr. Hartness was one of four contestants for the nomination, and won by a vote of nearly two to one over his nearest competitor. Nomination is tantamount to election, and he may be safely greeted as "the next Governor of Vermont."

James Hartness, Nominee for Governor

The Burlington (Vt.) *Daily Free Press* considers that the result marked "the triumph of the gospel of hope and progress for Vermont," and in commenting on the result says:

> The Hon. James Hartness of Springfield not only won the Republican nomination for Governorship, but he also gained a vote which at the hour of writing seems to have approached proportions of an actual landslide. . . . The people have been educated in this campaign to expect a genuine move toward a greater Vermont. We believe they will not be disappointed. Mr. Hartness will do his part. The only question now is whether we—the people of Vermont—will do our part to match his initiative and energy by helping to carry out his program for new opportunities for Vermont's youths.

The significant thing in Mr. Hartness' nomination is that it was accomplished by an engineer who used an engineer's methods, and that these methods won out before a jury of an American public. His success should have a potent influence in shaping public opinion in favor of such methods, and should be an inspiration to other engineers who are in a position to render effective service to the state or nation.

To understand the significance of the event, one must trace the history of the industries of Springfield, Vt., Mr. Hartness' home town. Those familiar with the machine-tool industry are acquainted with the remarkable industrial center which has developed in this community, comprising a number of prosperous firms which have sprung from the parent company, the Jones and Lamson Machine Company, which was established there through Mr. Hartness' efforts about 30 years ago. The spirit of the community has been to assist young men of inventive and administrative talent who have originated new tools and devices to establish organizations of their own under the direction of those who by training and experience are competent to conduct them.

As a result, Springfield has grown and prospered in marked contrast in this respect to most other towns of the state of corresponding size. The population of Vermont as a whole does not vary much from year to year. The larger towns and cities increase somewhat in size, but the smaller communities have a tendency to decrease. It is evident, therefore, that the fundamental problem in Vermont relates to those things which concern the organic life and growth of the state. It is evident that it is related only to a very slight degree to programs such as are usually propounded by legislators and politicians.

With characteristic originality, Mr. Hartness made a survey of the conditions of the state, and judged that something must be done to increase its industrial life which, in turn, would provide a better market for the produce of its farms and make the state an attractive abode for its young men. The broad-gaged policy which had been followed at Springfield had proved effective. Why should it not apply equally well elsewhere?

It was on this proposition that Mr. Hartness conducted his campaign, and in his first appeal to the public made the following statement:

> We can accomplish much by refining our business methods and in watching expenditures, but that will not make a material change in the conditions that confront us.
>
> I believe that the same spirit and energy that has been successfully displayed by Vermonters in agriculture, dairying, and various other state successes, can be displayed in other desirable industries providing we conduct a drive for industrial plant culture to awaken interest and activity.
>
> It is now proposed to inject this scheme of industrial plant culture into this campaign because it is the only way, it is the best way, it is the big way to solve our problems.
>
> One example of its working is found in the machine-tool industries that have grown from a single plant that brought $30,000 per year into the state in '89 to six plants that brought about $10,000,000 last year. The six plants are all prosperous and filled with young, enthusiastic people who are competent to start other plants. Nearly all of this sum comes into Vermont and is invested here.

As to the efficiency of legislation or administrative action in carrying out such a program, a recent bulletin issued in interest of the movement states: "A popular movement for carrying forward a state's interest in these matters constitutes a real big thing to be done at the present time. We can ignore the trend of this age of mechanism and machinery, or we can wake up to the importance of the plan of industrial plant culture. While we know that legislation cannot produce the skill of the worker or an artist, or the initiative of the industrialist, or the fruit of invention; the people can by popular opinion, expressed by the press and through their representatives in legislature, give encouragement or they can stifle and kill such development."

Noteworthy Papers on Labor, Management and Production

As repeatedly shown at the meetings of The American Society of Mechanical Engineers, both general and local, there is no single subject in which engineers are so vitally interested at the present time as that of labor and management. Of unusual interest to engineers, therefore, should be the September issue of *The Annals*, the bi-monthly publication of the American

Academy of Political and Social Science.[1] This contains a collection of 30 articles under the general title of Labor, Management and Production, divided under the four following headings: Part I, The Human Factor as the Heart of Industry; Part II, The Drift Toward Science in Industry; Part III, Some Major Problems of Industry; Part IV, The Manager's Part in the Adventure of Industry.

The series of papers was edited by Morris Llewellyn Cooke, Mem.Am.Soc.M.E., who has written the editor's preface outlining its scope and intent. Collaborating with him as editors were Samuel Gompers, President of the American Federation of Labor, representing organized labor; and Major Fred J. Miller, President, Am.Soc.M.E., representing the managers of labor.

In the selection of contributors, an effort was made to secure papers from two groups of authors of which the names of Mr. Gompers and Major Miller are representative; or, as expressed by the Academy when this issue of *The Annals* was planned, by the "organized workers" on one hand, and "scientists of industry" on the other hand. In selecting the latter, however, the editor states that "no one was asked to contribute to these pages simply because he owned something or employed somebody. Official standing in the labor movement and recognized service in the application of science to the purposes of industry have determined eligibility in every case." The contributors are from the United States, England and France, and it is pleasing to note that one of the French representatives in the list is Charles de Freminville, recently elected Honorary Member, Am.Soc.M.E.

The value to the engineer of such a selection of articles as comprised in this number of *The Annals,* as a source of information upon the problems of the labor movement, is well expressed by Major Miller in his foreword, who says:

"There can be no doubt that much of the misunderstanding between employer and employee may be traced to the fact that each reads, more or less exclusively, the publications that support his views—that indeed must do so, for reasons that are easily understood. Thus each side fails to get the other's viewpoint and it is certain that the industrial situation would be much improved if there could be more of that 'getting together' which accompanies a free interchange of views, to the end that each side may at least comprehend what the other stands for; and why."

Mr. Gompers, whose foreword is entitled The Workers and Production, recognizes in his opening paragraph that "production is the great world problem of today" and other of the labor representatives also take the stand for increased production as in the interest of the wage earner. Mr. Gompers says, however, that "The Workers and Production—the title under which I express these thoughts—means the workers and life. That is to say, the workers and the life of the nation, spiritual and mental as well as physical. To contribute to the thought that is centered upon a better life for those who work, upon a nobler life for the nation and a higher plane for it and the civilization of the world, is a privilege to be sought. The last drag upon the worker's heart and brain, upon his enthusiasm for service, upon his simple efficiency at the bench and forge, is the lingering ideal of production for profit alone. The greatest single achievement for progress possible to this day and this generation is the substitution in industry of the ideal of production for use—for service—and not for profit alone."

Major Miller, writing from the standpoint of industrial management, says:

> There are those who, for ten years or more, have recognized and have declared their conviction that the industrial world has been passing through a revolution—for the most part peaceful and constructive, but, nevertheless essentially, a revolution. The Hohenzollern war did not cause this revolution, but only accelerated what was already under way. Among other things it has shown us clearly that the old driver method of industrial management will no longer do. The workmen of the world and as well, the women of every country that participated in the war, have acquired by that participation a new status. Many of the industrial difficulties of the present day are due to the resistance of working men and women everywhere, to being forced back to their former and inferior status. They are insisting that if they are good enough to place their lives at the disposal of the forces of civilization, then they are good enough to have at least some voice in determining the manner of life they shall lead in the civilization they have striven, they hope successfully, to preserve.
>
> In every country of the world the trend, for years, has been toward democracy; and absolutism, both in governments and in industries, is being generally perceived to be an anachronism in this age of enlightenment. . . . The tendency is to reëxamine our position with respect to our terrestrial environment and to ask why, with the productive powers of man multiplied by myriads of inventions, as they have been within the past century, anyone able and willing to work should, at any time, even temporarily, be without an adequate supply of all that is needed to maintain in good health not only himself, but all who are naturally dependent upon him; and to obtain in addition a fair share of the luxuries which modern civilization is supposed to afford for those who live in civilized countries. . . .
>
> Many of the most profound and disinterested students of this, our greatest problem, believe that the modern tendency of those who labor to plan for action in their common interest is, after all, the best protection society can have against worse things—evils such as have been alluded to above and which history plainly shows have led often to violence, but almost inevitably to degeneration and social decay.
>
> All who are sincerely trying to understand the present course of events will rejoice that, perhaps now more than ever before, men of large affairs, of proven capacity for leadership, heads of important industrial concerns, are giving evidence of their conviction that autocracy in industries is irreconcilable with democracy in governments. Realizing the very great difference between a body of employees all enthusiastically coöperating toward one object and, on the other hand, a body of employees rendering only such service as they think necessary to hold their jobs, and only so long as they wish to hold them, these men are giving this problem their best attention.

Favors Printing Code of Ethics in Shape for Framing

The proposed Code of Ethics submitted by the Special Committee to the Spring Meeting at St. Louis (published in the September issue of Mechanical Engineering) is worthy of careful consideration by each member of our Society.

The prospect of a definite, concise, straightforward code of ethics adopted by the A.S.M.E. to supersede the present rather cumbersome and lengthy code is gratifying. Any code of ethics that will stand the test is, or should be, merely restatements in detail of the operation of the Golden Rule, which has been the age-old measuring rod that has successfully withstood the assaults of the critic and the cynic and today will withstand the onrush of modern tendency to limit and equalize by restraint the service rendered for compensation or remuneration.

The Code, when adopted, might well be printed in such a shape that it can be framed, so that it may be in constant evidence. By displaying such a code in his office, the engineer subscribes to all of the statements contained therein. Such a use should go far toward inspiring confidence in the individual engineer and in the profession as a whole; for the Code, as proposed, is a statement of high altruistic purpose.—E. S. Carman.

Dr. Samuel Sheldon Dies

Dr. Samuel Sheldon, for the past thirty-one years professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn, died on September 4 at Middlebury, Vt. Dr. Sheldon was born in Middlebury on March 8, 1862. He was graduated from the Middlebury College in 1883 with the degree of A. B. In 1886 he received his A. M. degree. During the next two years he studied at Wurzburg, Germany, and received the degree of Doctor of Philosophy there in 1888. During part of this time he was associated with Kohlrausch, the distinguished physicist, in his celebrated determination of the ohm as the unit of electrical resistance. He was awarded the degree of Doctor of Science from the University of Pennsylvania in 1906, and from Middlebury College in 1911.

Dr. Sheldon was a fellow of the American Electro-Therapeutic Association, fellow and past-president of the American Institute of Electrical Engineers, member of the American Physical Society, member and past-president of the New York Electrical Society, member of the American Electrochemical Society, of the Society for the Promotion of Engineering Education, of the Brooklyn Institute of Arts and Sciences, and president of its department of electricity. He was also a member and past-president of the United Engineering Society and chairman of its Library Committee.

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[1] 39th St. and Woodland Ave., Philadelphia, Pa.

The Federated American Engineering Societies

First Meeting of Its Governing Body, American Engineering Council, to be Held in November, at Washington, D. C.—The Purposes and Activities of the New Organization—Two More Societies Become Charter Members

THE first meeting of the American Engineering Council, the governing body of The Federated American Engineering Societies, will be held on November 18 and 19, at the New Willard Hotel, Washington, D.C. This will be an event of the greatest importance to the engineering profession.

The first session will be devoted to the election of temporary officers and the appointment of temporary committees, and the second to an address by J. Parke Channing, chairman of Engineering Council. Mr. Channing's address will review the activities of Engineering Council and will outline particularly the work of its many committees. The second session will afford an opportunity for the discussion of the purposes of the Federation and its field of activities.

The sessions of the second day will be given over to the election of permanent officers and the reports of committees. Herbert C. Hoover, president of the American Institute of Mining and Metallurgical Engineers, will address the convention during this session.

A complete program of the meeting is presented below:

Program of First Meeting of American Engineering Council of The Federated American Engineering Societies

Washington, D. C., November 18-19, 1920: Headquarters, New Willard Hotel.

THURSDAY, NOVEMBER 18, 1920

MORNING SESSION

8:30 a.m. Registration
10:00 a.m. Opening Session of American Engineering Council
  1 Call to Order
    Richard L. Humphrey, Chairman of the Joint Conference Committee, Consulting Engineer, Philadelphia, Pa.
  2 Election of Temporary Chairman
  3 Election of Temporary Secretary
  4 Appointment of Temporary Committees:
    (a) Program
    (b) Credentials
    (c) Nominations
    (d) Constitution and By-Laws
    (e) Plan and Scope
    (f) Budget
    (g) Resolutions.

AFTERNOON SESSION

2:00 p.m. Address—ENGINEERING COUNCIL, by J. Parke Channing, Chairman.
2:30 p.m. Discussion of the field of activity for The Federated American Engineering Societies.

FRIDAY, NOVEMBER 19, 1920

MORNING SESSION

9:00 a.m. 1 Report of Committee on Nominations
  2 Election of Permanent Officers
  3 Report of Committee on Constitution and By-Laws
  4 Formal Ratification of Constitution and By-Laws
  5 Report of Committee on Plan and Scope

AFTERNOON SESSION

2:00 p.m. 1 Report of Committee on Budget
  2 Report of Committee on Resolutions

EVENING SESSION

8:30 p.m. 1 Introductory remarks by the presiding officer, the Chairman of American Engineering Council
  2 Address by Herbert C. Hoover, President American Institute of Mining and Metallurgical Engineers (Subject to be announced later)
9:30 p.m. Informal reception and smoker.

SATURDAY, NOVEMBER 20, 1920

9:00 a.m. Organization Meeting of Executive Board, American Engineering Council.

The Purposes and Activities of the Federation

Since the future activities of the newly organized Federation is bound to be the central topic under discussion at the forthcoming meeting of the American Engineering Council a statement of the work in prospect and a review of the accomplishment of the present Engineering Council is of timely interest.

The questions are frequently asked, "What will be the field of activity of The Federated American Engineering Societies?" and "What does the organization intend to do?" Briefly, it will so consolidate the engineers of the country that they will present a solid front and join in an united effort for the proper handling of governmental and legislative matters of an engineering character. It will use its power for the service of the community, state and nation in public affairs wherever engineering experience and technical knowledge are involved, and will consider and act upon matters of common concern to the engineering and allied technical professions.

In the past Engineering Council has been fully alive to the need for concerted effort on the part of engineers in these directions and has accomplished notable results as already fully outlined in these columns. The following are some of the matters now pending before Engineering Council and with all of them the newly created American Engineering Council is destined to be greatly concerned.

(a) Classification and compensation of engineers
(b) Licensing of engineers
(c) Water conservation
(d) National Board for Jurisdictional Awards in the Building Industry
(e) National Public Works Department
(f) Assisting in the preparation of information for the Senate Committee on Reconstruction and Production
(g) Public affairs
(h) Military affairs
(i) New York state government reorganization
(j) International affiliation of engineers
(k) Curricula of engineering schools
(l) Patents
(m) Payment for estimating
(n) Booston-Washington super-power system
(o) Russian-American engineering coöperation
(p) Types of government contracts

In view of the good work which Engineering Council has accomplished and is now doing the questions arise:

If Engineering Council is a success, why should the proposed Federation supplant it?

If Engineering Council is a failure, why should the Federation be organized along lines so nearly parallel?

Chiefly, in answer to the first question, to establish an organization which shall be representative of engineers everywhere so that all may have a voice and exert their influence in the great affairs of public concern with which a central body would be expected to deal. Engineering Council has six member-societies. At the Organizing Conference for the Federation 71 societies were represented with an aggregate membership of over 80 per cent of that represented by the 110 societies which were invited. As expressed in the bulletin of the Joint Conference Committee, which is now acting for the Federation, the organization of Engineering Council is "from the top downward," whereas the Federation, which came into being in response to a widespread movement throughout the country, has been organized from the "bottom upward" and rests upon a foundation so broad that every engineering society of acknowledged standing may become a supporting element.

The Constitution and By-Laws of the Federated American Engineering Societies for the first time provide a plan for bringing about solidarity in the engineering profession—a plan which assures success because it does not interfere with the existing engineering and allied technical societies.

The answer to the second question is that the Engineering Council has not been a failure, but on the other hand has done a magnificent work. The deficiencies of Engineering Council are not in the quality of the work which it has accomplished, but rather have been due to its organic limitations and to the fact that it is not sufficiently representative of the local, state and regional organizations and affiliations. The Organizing Conference in Washington laid the foundation for a more democratic organization in which the local, state, and regional engineering and allied technical organizations, and affiliations, will be represented, and will have a real voice in the management of its activities.

The Organizing Conference thus recognized the successes and limitations of Engineering Council and has evolved an organization in which all of these successes will be utilized and a broader opportunity afforded for more effective work on behalf of the engineering and allied technical professions.

Societies Rapidly Organizing for Federation Support

A. S. M. E. Appoints Its Delegates to American Engineering Council.

The Council of The American Society of Mechanical Engineers recently appointed its representatives on the American Engineering Council, the governing body of The Federated American Engineering Societies. The mechanical engineers will be represented by fourteen delegates who, under the By-Laws of the Federation, are appointed for a period of two years. A list of those named by the A.S.M.E. will be found on page 135 of Section Two.

American Institute of Electrical Engineers Becomes Charter Member.

The American Institute of Electrical Engineers is the second national engineering organization to join the Federation. This action by the Institute was taken at a meeting of the Board of Directors held in New York on August 12 when the following resolution were unanimously adopted:

Resolved, That the American Institute of Electrical Engineers accepts the invitation to it to become a Charter Member of The Federated American Engineering Societies, and pledges its hearty coöperation in the work thereof.

American Society of Civil Engineers to Vote on Joining Federation.

The American Society of Civil Engineers at a convention held in Portland, Oregon, during August voted to refer the question of joining the Federation to its corporate membership. The resolutions adopted provided:

"That the Board of Direction of the American Society of Civil Engineers be directed to submit at once the question of the American Society of Civil Engineers becoming a charter member of The Federated American Engineering Societies to referendum vote to the Corporate Membership of the American Society of Civil Engineers as recommended by the Joint Conference Committee, said ballot to be accompanied by a copy of the Constitution and By-Laws of said Federation, and

"That the Board of Direction of the American Society of Civil Engineers be further instructed in the event of a favorable vote on said referendum to proceed at once to take such steps as may be necessary for the American Society of Civil Engineers to become affiliated with said Federation."

Cleveland Engineering Society Is Fifth Member of the Federation.

The Cleveland Engineering Society at its meeting of August 10 voted to become a Charter Member of The Federated American Engineering Societies. The Cleveland society is the fifth organization to join the Federation, the first four in their order of affiliation being, respectively, The American Society of Mechanical Engineers, the Detroit Engineering Society, the Technical Club of Dallas, and the American Institute of Electrical Engineers.

THE CONSTRUCTION PERIOD

(*Continued from page 561.*)

land is $1,200,000 and the structural property $10,800,000. The purchase of land is started one year before construction and continues for three years, the construction period is also three years, the assessment is made in mid-year of each construction period. The assessor will find 70 per cent of the construction cost, the rate is 2 per cent. The amount put into property each year is as follows:

	Land	Structural Property	Total
First Year	$400,000	....	$ 400,000
Second Year	400,000	3,600,000	4,000,000
Third Year	400,000	3,600,000	4,000,000
Fourth Year	....	3,600,000	3,600,000
Total	$1,200,000	$10,800,000	$12,000,000

Solution:

Total cost end of first year	$ 400,000	
Cost at middle of first year	200,000	
Assessment @ 70%	140,000	
Taxes paid first year 2% of $140,000		$ 2,800
Total cost at end of second year	4,400,000	
Cost at middle of second year	2,400,000	
Assessment @ 70%	1,680,000	
Taxes paid second year 2% of $1,680,000		33,600
Total cost at end of third year	8,400,000	
Cost at middle of third year	6,400,000	
Assessment @ 70%	4,480,000	
Taxes paid third year 2% of $4,480,000		89,600
Total cost at end fourth year	12,000,000	
Cost at middle of fourth year	10,200,000	
Assessment @ 70%	7,140,000	
Taxes paid fourth year 2% of $7,140,000		142,800
Total taxes paid		$268,800

$$\frac{268{,}800}{12{,}000{,}000} = 2.24 \text{ per cent}$$

As in the cast of interest, before the final percentage to include for taxes during construction can be determined it will be necessary to know what method was used in finding the reproduction cost, if "piece-meal" the percentage will be one thing, if "wholesale" it will be another. The proper amount to include for taxes finally depends on first, the length of the construction period; second, what per cent of the construction cost will the assessor find; third, the tax rate.

Engineering Foundation Seeks Large Endowment

Research Organization Asks for $1,000,000 to Assure it of Adequate Funds for Present and Future Undertakings

THE Engineering Foundation, created in 1914 by the United Engineering Society, is now seeking to increase its endowment to at least a million dollars. The Foundation is based on gifts from Ambrose Swasey, of Cleveland, Ohio, Past-President Am.Soc.M.E., aggregating $300,000 and intended to be the nucleus for a much larger endowment fund. It was established "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind." Its income, however, is entirely inadequate to meet the ever increasing demands, and, in order that the researches now in progress may be continued and those contemplated be undertaken as may be required from time to time, an increase of endowment is thus being sought. The foundation desires gifts of $1000 or more, and it has announced that any person giving $250,000 will be honored as a Founder. Charles F. Rand, of 71 Broadway, New York, Past-President American Institute Mining and Metallurgical Engineers, is chairman of the Foundation. The offices of the Foundation are in the Engineering Societies Building, 29 West 39th Street, New York, Alfred D. Flinn, Secretary.

The endowment funds of the Foundation are owned by United Engineering Society, a New York corporation, for the four national societies. The income is administered by a board composed of thirteen representatives of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and three members at large. Because of the liberal form of its organization, the Foundation can support researches conducted either by individuals or by organizations; establish and operate research laboratories; aid in applying to engineering the results of the researches in the sciences, and in numerous ways aid in stimulating interest in research among engineers and the industries.

The results to be obtained through research cannot, however, be achieved in a short space of time, but, nevertheless, in its brief existence, Engineering Foundation has accomplished noteworthy results. Since 1916 it has maintained a liaison with scientists through the National Research Council, an organization called into being at the request of the President of the United States and which, because of its relation to the Federal Government, is therefore in a position to be intimately connected with the research problems both of the industries and governmental departments.

At present a most important research is being carried out, in which both the Foundation and the Division of Engineering of National Research Council are interested. It is concerned with the fatigue phenomena in metals. This highly important subject is being investigated at the Engineering Experiment Station of the University of Illinois and is being financed to the extent of $30,000 by the Foundation. Recently the General Electric Company requested that it be permitted to coöperate in the work in order that the program of tests might be extended. The September 1919 issue of MECHANICAL ENGINEERING contained a progress report of the committee appointed to carry on this research, and in it will be found a complete summary of the facts and theories relating to fatigue phenomena so far as at present known.

Another of the Foundation's researches is concerned with the wear of gears. This study begun in 1916 was interrupted by the war and was not resumed until the past summer. The work is being conducted at Leland Stanford Junior University.

In 1917 the Foundation joined with the New York Committee on Submarine Defense in a series of experiments on the concealment of ships by means of spray from special nozzles placed at suitable points on the vessel. This method of protecting ships was found, however, to be impractical.

One of the Foundation's most recent researches has resulted in an improved form of weir for gaging the flow of liquids in open channels. This research was conducted by Clemens Herschel, a noted hydraulic engineer, and a past-president of the American Society of Civil Engineers. The experimental work was conducted in collaboration with the Hydraulic Laboratory of the Massachusetts Institute of Technology and the results obtained were presented as the leading article in MECHANICAL ENGINEERING for February 1920.

Still another phase of research was undertaken in 1919, when the Foundation authorized Dr. E. E. Southard, the late Director of the Massachusetts State Psychiatric Institute, to undertake an investigation of the place in industry of the mentally deficient. The objects of Dr. Southard's research were to develop or discover methods for recognizing and suitably placing persons of slightly abnormal mental characteristics and for adapting psychopathic individuals to usefulness in industry, but his untimely death prevented the conclusion of his work. He had, however, completed three preliminary papers which appeared in the February, April, and June 1920 issues of *Industrial Management* (New York).

Research in mental hygiene of industry deals, however, with but one of the many groups of problems peculiar to industrial personnel relations. The Foundation has, therefore, coöperated with the National Research Council in planning a conference of leading industrial, labor and scientific bodies interested in this field to consider the possibility of comprehensive, unbiased study of the subject. Arrangements for the preliminary conference are well advanced and the meeting will be held this fall in Washington, D. C. Attention will be directed to the non-controversial elements of the subject, capable of scientific study.

In the latter part of 1918, Julius Alsberg, a consulting hydraulic engineer, suggested to the Foundation that there be established a station for the testing of large water wheels and other large hydraulic equipment. The Foundation immediately appointed a committee consisting of Silas H. Woodard, H. Hobart Porter, and Calvert Townley to investigate the matter. In May 1919, the committee reported that such a testing station was not feasible; that it was not necessary to establish a testing flume for small models, as existing flumes met all requirements; but that testing of water wheels now in place would be useful and practicable.

The Engineering Foundation has thus covered several diversified fields and has been limited as to the extent of its investigations solely because of its limited resources. Many important research projects which promised valuable results could not be undertaken because of lack of funds, and it is to provide for these that the Foundation is now engaged in increasing its endowment.

To those who desire more detailed information of its activities, the Foundation will be pleased to send a booklet descriptive of its organization and work.

Several calls for assistance have come to the Society from engineers in Austria, which indicate the desperate situation in which many are now placed in that country. The latest appeal comes from Innsbruck from the Technischer Verein Innsbruck, which says:

"To give you an instance of our precarious position, it would require, in consequence of the debasement of our money, the sevenfold amount of the entire funds of our society to procure a typewriter and a copying press, an amount which we would not be able to raise in addition to paying the current expenses of the society. We are in great need of these two machines in order to circulate items of a technical character among our members, and take the liberty of addressing ourselves to you and of soliciting your assistance in helping us to secure a second-hand typewriter and a copying press. Will you kindly send reply addressed to the Chairman of our Society, Mr. Julius Gruder, Engineer, Innsbruck, Postbox 79."

Government Activities in Engineering

Notes Contributed by The National Service Department of Engineering Council[1]

Organization and Status of Federal Power Commission

The Federal Power Commission which was created to administer the Water Power Act, passed and signed by the President in the closing days of the last Congress, has been organized along the following lines: engineering, accounting, statistical, regulatory, licensing, legal, and operation. It is apparent that the engineering division will be the most important because it will make general investigation of the electric power industry, power sites, costs, and development.

Unfortunately the actual work of the Commission has been somewhat hampered because the Comptroller of the Treasury has ruled that, under the terms of the act, there is no money available to pay the required personnel. This means that the personnel will have to be assigned to the Commission by the various Departments until such time as appropriations can be made to pay for the required assistance. Thus far Lt-Col. Kelley of the Engineers Corps has been assigned as engineer officer, and Major L. W. Call of the Judge Advocate General's office as chief counsel.

One of the chief duties of the new Commission has been to formulate regulations that would make the applications for water-power privileges valid. These regulations were drawn up by the Secretary and all interested Government Departments and outside organizations were invited to send their representatives to a Washington conference on August 12 for the purpose of discussion in making further recommendations. This meeting was followed by another conference the next day with representatives of interested financial institutions, so that their recommendations could also be considered before the application was put into final form.

Some regulations covering applications for permits and licenses under the Water Power Act were approved at the September 3d meeting of the Commission, and those covering construction, operation and maintenance of projects are now in process of preparation. It is contemplated that further hearings on these regulations will be held before they are finally adopted.

District offices of the Commission have been opened at St. Paul and St. Louis in the local offices of the Corps of Engineers, and in Denver and San Francisco in the legal offices of the Forest Service.

Effect of Navy Wage Award on Salaries of Technical Men

On September 9 the Secretary of the Navy announced the new schedule of pay which had been made in accordance with the recommendations of the Navy Wage Adjustment Board. This is the first adjustment that has been made since the Macey Board Award in February, 1919.

In general, the various employees of the Navy receive increases of 5 per cent in pay except where the pay is more than eight dollars per day, so that the award does not include the engineers, architects, and draftsmen in the raise. In fact, they are adversely affected because the new schedule requires that all employees of the Department shall observe the standard working day of eight hours. This means that when the order becomes effective technical men will suffer a decrease of about 8 per cent in their present pay because of the loss of one-half day each week. This, combined with the fact that the working day is increased from seven to eight hours, makes an average approximate decrease of 20 per cent in compensation.

National Committee for Governmental Economy

There are at least four important agencies carrying on a propaganda for some modification of the administrative branch of the Federal Government. These are, (1), the Budget Committee; (2), National Public Works Department Association; (3), National Education Association; (4), American Public Health Association.

Of these the National Budget Committee has taken the lead in the formation of a National Committee for Governmental Economy which is preparing a general plan for a reorganization of the administrative branch of the Government. This is for the purpose of coördinating the work of any departments which may be formed as a result of the proposed reorganization as, for instance, if a Department of Public Works is created, it is desired that this shall harmonize with other adjustments which must ultimately be made, and the same is true of the Department of Public Health or the Department of Education should they be formed.

The staff of the Committee comprises Stanley Howe, Director of Organization of the Budget Committee, who has the same duties with the new Committee; C. T. Chenery, Executive Secretary for the National Public Works Department Association, is Executive Secretary; and Harold N. Graves, Assistant Chief of the Bureau of Efficiency, is directing the reorganization study. The Committee has offices at 700 Tenth Street, N.W., Washington, D.C., and will issue progress reports from time to time.

Relative Importance of Mining and Agricultural Appropriations

Appropriations made by the last Congress show only one-thirteenth as much for the promotion of the interests of the mining industry as is shown for promotion of corresponding interests in the agricultural industry. The ratio of economic importance of these two industries is but one to four. Official reports for 1918 show that the total value of mineral products was roughly five and one-half billion dollars, while the value of agricultural products totalled approximately twenty-two and one-half billion dollars. Of course the agricultural industry is more diversified in all of its aspects, but those interested in the various phases of mining work contend that this does not make up for the great difference in ratio of expenditures.

It is now contended that the Bureau of Mines should assist the chemical industries in the same way that it extends its assistance to metal-mining and coal-mining industries, because of the fact that they are so closely allied to the Bureau's present work. It is hoped that the gathering of statistics and the study of problems pertinent to the chemical industries will be taken up by the Bureau of Mines during the next fiscal year.

Census of Central Electric Light and Power Stations

A partial report dealing with Central Electric Light and Power Stations for 1917 was issued by the Census Bureau on September 7. It is part of a more complete report which covers railways, telephones, telegraphs, and municipal electric fire alarm and police signaling systems, and which is the most complete and valuable census ever taken of American electrical industries.

The report which has just been issued covers the general development of Central Electric Light and Power Stations of both the steam and hydroelectric type. The general record of primary power equipment with special attention to generating equipment, line equipment and substation equipment is also presented, and the output and disposal of current is classified. Very comprehensive financial statistics are also given with special comparative financial and operating summaries of selected groups of electric stations. The report likewise contains some interesting data on employees, salaries, and wages.

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[1] Engineering Council is an organization of national technical societies created to consider matters of common concern to engineers as well as those of public welfare in which the profession is interested. The headquarters of Engineering Council are located in the Engineering Societies Building, 29 West 39th Street, New York City. The Council also maintains a Washington office with M. O. Leighton, chairman of the National Service Department, in charge. This office is in the McLachlen Building, 10th and G Streets, Washington, D. C. The officers of Engineering Council are: J. Parke Channing, *Chairman;* Alfred D. Flinn, *Secretary.*

Mining Engineers Visit Lake Superior Copper and Iron Country

The 122d Meeting of the Institute of Mining and Metallurgical Engineers Held at Points in Michigan and Minnesota, with Inspection Trips to the Great Mining Properties of Lake Superior District

A GENERAL trip of study and inspection of the Lake Superior iron and copper country was a feature of the 122d meeting of the American Institute of Mining and Metallurgical Engineers. Members left Buffalo on August 20, visited the copper mines in and about Houghton, the iron mines of the Marquette and Iron Ranges of Michigan and those of the Mesabi Range in Minnesota, and returned to Buffalo on September 3. Technical sessions were held at Houghton, Minneapolis and Duluth. A banquet was also held at Minneapolis, Herbert Hoover, President of the Institute, delivering the principal address.

Address by Herbert Hoover

Mr. Hoover spoke in advocacy of a definite national program in the development of our great engineering problems and emphasized the need for a National Department of Public Works. He said in part:

> Our rail and water transport, our water supplies for irrigation, our reclamation, the provision of future fuel resources, the development and distribution of electrical power, all cry out for some broad-visioned national guidance. We must create a national engineering sense of provision for the nation as a whole. If we are to develop this national sense of engineering and its relations to our great human problems it must receive the advocacy of such institutions as this.
>
> We, together with our sister engineering societies, represent the engineers of the United States. It is our duty as citizens to give voice to those critical matters of national policy which our daily contact with this, the fundamentally constructive profession, illuminates to us. Just as our medical associations voice the necessity of safeguards to national health; as the bar associations safeguard our judiciary, so the engineers should exert themselves in our national engineering policies. We have none, but we need some, or the next generation will face a lower instead of a higher standard of living than ours.

Continuing, Mr. Hoover discussed the great national engineering problems of coal and petroleum supply, rail and water transportation, mountain water storage, irrigation, lumber supply, etc., and said:

> All these problems are much akin, and the time has come when they need some illumination, guidance, and coöperation in their solution from the Federal Government. Nor do I mean a vast extension of Federal bureaucracy in Federal ownership. If, in the first instance, through an agency of the central government, we could have an adequate study and preparation of plan and method made of these problems of engineering development over the next fifty years, viewed solely in their national aspects, we would have taken the first step toward the adequate provision of an increasing standard of living and a lower cost of living for our descendants.
>
> The second step is to determine that our government will be a government of coöperation, limiting profits surely, but holding to individual initiative as the single hope of human development. In order that we shall have some central point in the Federal government where these problems may be adequately considered, from which they can be ventilated for the verdict of public opinion, where the business brains of the country can be called into conference and coöperation with the government, and therefore with the people, the engineers of the United States have proposed time and again that a Cabinet department should be established in Washington, either new or to replace the Interior Department, to which should be assigned the whole question of public works. . . .
>
> Such a department has become an essential from the point of view of proper consideration and presentation to the American people of these broader national engineering problems, upon which the next generation must depend if our country is to march forward.

Technical Papers

A paper on the Handling and Treatment of Rock-Drill Steel at Copper Range Mines was presented by H. T. Mereer and A. C. Paulson. The shank is formed in a bulldozing machine, a pin 5 in. long being first inserted in the hole to maintain it. After being formed the pin is removed and the shank reheated and quenched in oil. A 1/64-in. clearance is allowed between the shank and drill chuck. All shanks are made without lugs, except in a few cases where the drills are to be used in loose ground. Collars are formed on the Jackhammer steel only. Results obtained in heat-treating experiments were also mentioned. Drills were suspended in a chloride bath and the heat regulated by a pyrometer. They were then quenched in tempering oil, a 10 per cent solution of brine, or water, and tests run on each in the mine under uniform conditions. Other tests were made with a further treatment by tempering or drawing. It was concluded that the additional treatment after hardening was altogether unnecessary. No practical difference was found between heating in a chloride bath or in a coke furnace, provided temperature regulation was maintained equally as well in both cases. Water at a temperature of 80 to 100 deg. fahr. was determined to be the best quenching medium for the conditions existing in the mines.

How steam regenerators reduce coal consumption at the mines of the Copper Range Company was told by W. H. Schacht. The hoists furnish the only available supply of exhaust steam. The method of treating a flux of intermittent exhaust steam by the use of steam regenerators consists in passing the steam through a closed vessel, or regenerator, in which it is condensed and reevaporated. Condensation takes place when the steam is in excess of the quantity required to maintain a constant flow of outgoing steam, and reëvaporation takes place when the steam discharged into the regenerator is not sufficient to maintain this constant flow. The steam from the regenerator is delivered to the buildings to be heated with a drop in pressure not exceeding 2 lb. at times of greatest demand and about 1 lb. during average winter conditions. A two-pipe system is used. In the buildings the drainage of mains and return lines is in the direction of the flow, thus eliminating all water hammer. Syphon traps are used on all radiators, direct and indirect, and on all headers and drips. The air and condensation are collected into and returned by a 3-in. line, the end of which is submerged, forming a water seal that is located in the boiler house. At a point about 20 ft. above the overflow of this water seal is located an air separating tank, from which the air and non-condensable vapors are drawn from the system by a Nash No. 0 vacuum pump, requiring for its operation about 1½ hp. This pump is operated by an electric motor. The pressure carried on the regenerator, being also the back pressure on the hoist, varies from 8 to 10 in. vacuum to ½ lb. above the atmosphere; the colder the weather, the lower is the average of the range maintained. The return-line pressure is usually constant at about 18 in., making a working pressure available, therefore, of about 8 lb., which is more than sufficient in almost any emergency. There was a slight reduction in the tons hoisted in most plants during the year following the regenerator installations, but this did not affect the coal consumption materially, for some live steam was usually required for heating.

Surface Changes of Carbon Steels Heated in Vacuo, by E. Heaton Hemingway and George R. Ensminger, contained an account of experiments conducted at the Watertown Arsenal. Samples of steel were held at 1000 deg. cent. in vacuo for 10 hours. Three types of markings were discerned: (1) A deeply marked polyhedral structure, which represented the final gamma boundaries; (2) a fine clean-cut structure, which was brought out more clearly by etching, that represented the alpha boundaries; and (3) an indefinite and often partly obliterated structure that represented the boundaries of former gamma crystals that had been absorbed by crystalline growth. The outside layer consisted of ferrite as result of the iron having been volatilized and redeposited below the temperature at which solid solution exists. Iron oxide reacted with the carbides in steel at temperatures below 1000 deg. cent. to form carbon monoxide and pure iron.

Other papers were presented, among which were the following: Efficiency in the Use of Oil as Fuel, by W. N. Best; Industrial Representation in the Standard Oil Co. (N. J.), by C. J. Hicks; A New Process for Making Fifteen Per Cent Phosphor Copper, by P. E. Demmler; and The Charpy Impact as Applied to Aluminum Alloys, by E. H. Dix, Jr.

LIBRARY NOTES AND BOOK REVIEWS

A Course in Electrical Engineering. Vol. I. Direct Currents. By Chester L. Dawes. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 x 8 in., 496 pp., illus., $4.

The present book is the first of two volumes which are intended to serve as a comprehensive text covering the general field of electrical engineering in a simple manner. It will be useful, the author believes, to students of electrical engineering as an introduction to more advanced texts and also to students who are studying the subject for general training, without the intention of becoming specialists. The treatment is detailed, straightforward and systematic, but avoids much mathematical analysis.

The Design of Highway Bridges of Steel, Timber and Concrete. By Milo S. Ketchum. Second edition, rewritten. McGraw-Hill Book Co., Inc., New York, 1920. Flexible cloth, 6 x 9 in., 548 pp., illus., diagrams, charts, tables, $6.

This new edition has been made necessary by the increase in live loads due to the extensive use of heavy motor trucks and tractors, and the increased use of reinforced concrete in highway bridge construction. The scope of the book has been extended to include the design of concrete and timber bridges as well as steel bridges. The discussion covers all the details of constructing highway bridges. This edition is uniform with the author's Structural Engineers' Handbook.

Dredging Engineering. By F. Lester Simon. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 x 9 in., 182 pp., illus., plate, tables, $2.50.

The author of this volume has attempted to supply a work which will describe the principal types of dredges in such a manner as to impart a fundamental working knowledge of their construction and operation. He also takes up concisely the problems that confront the engineer in the conception and accomplishment of dredging projects.

Earthwork and Its Cost. A Handbook of Earth Excavation. By Halbert Powers Gillette. Third edition. McGraw-Hill Book Co., Inc., New York, 1920. Flexible cloth, 5 x 7 in., 1346 pp., illus., tables, $6.

This treatise covers systematically and comprehensively the methods of excavating for engineering work of all kinds. In addition to the results of his own experience, the author has included a summary of the material in American technical literature. Particular attention is given to cost data. The present edition has been revised.

Flugtechnik: Grundlagen Des Kunstfluges. By Arthur Pröll. R. Oldenbourg, München and Berlin, 1919. Paper, 9 x 12 in., 332 pp., illus. 30.25 marks (33 marks, pound).

This treatise is founded on a manual of the scientific foundations of the subject, prepared for practical self-instruction while the author was director of the aeronautical experiment station of the Austrian war ministry. The notes prepared for this purpose were used later in connection with his lectures on technical aerodynamics in the Hannover High School, from which the present work has been prepared. The book, therefore, presents the subject from the viewpoint of immediate practical usefulness and also emphasizes the connection of aeronautical calculations with the teachings of mechanics. It will serve, the author believes, not only as a text for students, but will also enable the experienced engineer to carry out designs and construction in all details, when combined with practical numerical data. The discussion is confined to monoplanes and biplanes of the usual type.

How to Manage Men. The Principles of Employing Labor. By E. H. Fish. The Engineering Magazine Co., New York, 1920. Cloth, 6 x 9 in., 337 pp., $5.

This volume is a discussion of the relations between workers and their employers, in which an attempt is made to evaluate the things that go to make a satisfactory working organization. The author discusses the establishment of an employment department, the problems of the employment manager, the promotion of industrial relations, and industrial education.

The Iron and Steel Industry of the United Kingdom Under War Conditions. A Record of the Work of the Iron and Steel Production Department of the Ministry of Munitions. By F. H. Hatch. Privately printed for Sir John Hunter by Harrison and Sons, London, 1919. Cloth, 6 x 10 in., 167 pp., illus., plates, portraits, charts, tables.

This volume is an interesting account of the methods used by the British Government to obtain the necessary increase in the steel production of Great Britain during the war. The vastness of the field covered, the variety and complexity of the technical problems involved and the far-reaching industrial questions raised, make the subject one of great interest and importance.

MacRae's Blue Book. MacRae's Blue Book Co., Chicago and New York, 1920. Cloth, 9 x 11 in., 1853 pp., $10.

An alphabetically arranged directory of American manufacturers, which is especially full with respect to iron and steel products, and the materials used by railways and in building. In addition to the directory of materials it contains a list of addresses, and also of trade names, a standard list of prices and a collection of data used by buyers. Thirty thousand firms are included.

Marine Engineers' Handbook. Prepared by a staff of specialists, Frank Ward Sterling, Editor-in-Chief. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Flexible cloth, 5 x 7 in., 1486 pp., illus., tables, $7.

This handbook is compiled for the use of operating and designing engineers, and students. To cover the main subjects and the many ramifications of marine engineering, it has been necessary to enlist the services of thirty specialists, each of whom has received the hearty coöperation of others in the same field. The best endeavor has been made to coördinate different practices in order that all data may be reliable and unbiassed. The handbook is a pioneer in its field.

Mathematics for Engineers. Part II. By W. N. Rose. E. P. Dutton and Co., New York, 1920. Cloth, 6 x 9 in., 419 pp., illus., tables, $7.

The work of which this is the second volume is intended to occupy a position midway between those written for college students, which are usually academic in character, and those practical books which omit any discussion of the scientific basis underlying them. It is intended to contain all the mathematical work needed by engineers in their practice and by students of all branches of engineering. This volume treats of the differential and integral calculus, spherical trigonometry and mathematical probability.

Personnel Administration. Its Principles and Practice. By Ordway Tead and Henry C. Metcalf. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 x 9 in., 538 pp., $5.

The purpose of this book is to set forth the principles and the best prevailing practice in the field of the administration of human relations in industry. It is addressed to employers, personnel executives, employment managers and students of personnel administration, but will have value, the authors hope, also for all who are interested in advancing right human relations in industry and in securing a productivity that is due to willing human coöperation, interest and creative power. The field covered includes those efforts usually included in personnel management, employment, health, and safety, training, personnel relations, service features and joint relations. The book also seeks to show the relation of the personnel problems of each corporation to those of its industry as a whole, by considering the activities of employers' associations and organizations of workers.

Railroad Curves and Earthwork. By C. Frank Allen. Sixth edition, revised. N. Y. and London, McGraw-Hill Book Co., Inc., New York, 1920. Flexible cloth, 4 x 7 in., 289 pp., diagrams, charts, tables, $4.

This book has been prepared for the use of the students in the author's classes at the Massachusetts Institute of Technology, but it will also, he believes, be useful to engineers who have to deal with earthwork computation or curves. The new edition is marked by an extension of the treatment of circular arcs; by new methods for the computation of earthwork, additional data on haul, and by general revision.

The Rudder Marine Directory. A Trade List of Shipbuilding and Marine Industries. Rudder Publishing Co., New York, 1920. Cloth, 6 x 9 in., 438 pp., $5.

The title of this directory is sufficient indication of its contents, and suggests its possible usefulness to those interested in ship construction and operation. The present edition is considerably larger than the first, which appeared in 1919. The lists are conveniently classified and arranged to facilitate their use.

Die Schaltungsgrundlagen der Fernsprechanlagen mit Waehlerbetrieb. By Fritz Lubberger. R. Oldenbourg, München & Berlin, 1920. Boards, 9 x 13 in., 168 pp., plates, 28 marks.

This book is intended to give engineers acquainted with manually-operated telephone exchanges an introduction to automatic systems, which are frequently so confusing to the beginner. The author has made an extended examination of the systems of wiring used or proposed for this purpose and has selected the essentials of proper procedure from them. Beginning with an easily understood automatic circuit, the book then proceeds to describe generally the principles of the various parts of the circuit, and follows this with explanations of the various systems that have been devised for the practical solution of the problems involved. The book includes bibliographical references, a list of German patents and many plates illustrating the arrangements described.

Storage Batteries. A Practical Presentation of the Principles of Action, Construction, and Maintenance of Lead and Non-lead Batteries and their Principal Commercial Applications. By Morton Arendt. American Technical Society, Chicago, 1920. Flexible cloth, 6 x 7 in., 136 pp., illus., plate, tables.

Important changes have taken place with the last ten years in the construction of the storage battery, and the principles of the design and manufacture of this "savings bank" of the electrical industry have been studied with the view of making it even more efficient. The importance of proper charging methods, testing, locating and remedying troubles are treated in detail in this volume, which also covers the methods of use by the large generating stations, in the telephone and telegraph industries and in electric vehicles. The work is adapted for home study by beginners as well as for experts.

Structural Steelwork. Relating Principally to the Construction of Steel-framed Buildings. By Ernest G. Beck. Longmans, Green and Co., New York, 1920. Cloth, 6 x 9 in., 462 pp., illus., tables, $7.50.

This book presents information likely to be of use in the design and construction of ordinary steel-framed structures. The principal endeavor has been to be broadly suggestive, rather than particular or exhaustive, to propose commonsense lines of argument based upon straightforward consideration of the facts, instead of attempting to generalize or formulate specific relations from details which cannot be more than typical. The work follows British practice, and is based upon a series of articles contributed to the *Mechanical World*.

Textbook of Aero Engines. By E. H. Sherbondy and G. Douglas Wardrop. Frederick A. Stokes Co., New York, (Copyright 1920). Cloth, 9x12 in., 363 pp., illus., diagrams, plates, $10.

The present work is a review of the theory and practice of the design of engines for aerial navigation. The first part treats of theory and includes the theory of the cycle, the work available, the effect of altitude, pressure, etc., on the power, and the theory and design of compressors. The second part describes the current types of American, British, French, German and Italian engines An appendix gives tables of use to designers. The book is fully illustrated with drawings and photographs.

Technical Gas and Fuel Analysis. By Alfred H. White. Second edition, revised and enlarged. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6x8 in., 319 pp., illus., tables, $3.

The first edition of this work, which appeared in 1913, was intended to present the conclusions of the various committees of technical societies which had reported on the testing of fuels and their utilization. Since 1913 our knowledge of gas and fuel analysis has been distinctly increased. Standard methods for sampling and analyzing coal and coke and for examining liquid fuels have been adopted by several societies. Methods for gas analysis have been critically studied and new methods developed. These advances have been carefully reviewed for this edition, which is about 20 per cent larger than the former one.

Utilisation Des Vapeurs d'Echappement Dans Les Houilleres en Vue de la Production d'Energie Electrique. By Adrien Barjou, preface by Maurice Soubrier. Gauthier-Villars et Cie., Paris, 1920. Paper, 6x10 in., 90 pp., illus.

The author of this work discusses the utilization of exhaust steam in low-pressure turbines for the production of electricity or compressed air. The particular case studied is that of coal mines which have outgrown their power plants and are faced with the necessity of extending them. The economic and technical results obtained with low-pressure turbines are set forth in this book.

Wiring for Light and Power. A detailed and fully illustrated commentary on the National Electrical Code. By Terrell Croft. Second edition. McGraw-Hill Book Co., Inc., New York, 1920. Flexible cloth, 5x8 in., 465 pp., illus., tables, $3.

The purpose of this book is to supply explanations, elaborations and illustrations for those sections of the National Electrical Code to which most frequent reference is necessary. For this purpose the most important Code regulations are given verbatim, and their application in practical electrical construction is explained by supplementary text and drawings. This edition has been fully revised to correspond with the 1918 edition of the Code.

THE EFFECT OF DEPTH OF COPPER PLATING ON CARBURIZATION

(*Continued from page* 566.)

An ocular micrometer was used to measure the depth of case. The depth t of the plating was calculated from the formula t (inches) $= C/145.845A$, in which $C =$ weight of copper deposited, grams; $145.845 =$ weight of 1 cu. in. of copper, grams (assuming specific gravity $= 8.9$); and $A =$ area of surface of deposit, sq. in.

Data from tests of sets B, D and E are given in Table 1. From these it may be seen that the carbon had just started to leak through the copper plating and in all specimens, including those of sets A and C, there was no case below the copper that would ever be noticed in practical work. The amount of copper which analysis does not show and which is due to solution in the iron or any other cause at all is certainly low; and allowing 10 per cent for this would give a safe margin. It is believed that for a 10 to 12 hour heat not over 0.0002 in. need ever be used. In event such an amount of copper is used the only care that should be taken is to have plenty of the carburizing agent present so that it will not be exhausted and the copper oxidized by reaction in which $2CO_2 + Cu$ becomes $CuO + 2CO$.

In examining the specimens under the microscope the corners of the pieces were given considerable attention. At this point the carbon could enter the steel back of the copper. In some 60 per cent of all specimens, however, such was not the case, and it seemed that the copper exerted some influence to keep carbon from the steel even though it was not directly in contact with it.

The photomicrographs taken—Figs. 1 to 6—show the typical appearance of specimens examined. With the exception of the original, these pictures were taken of piece No. 30; they show very clearly that no carbon penetrated the copper, and that at the same time a good cementation was effected on the back.

These experiments would tend to show that in copper plating with a current of as low density as the one employed:

1 There is no need of using as deep a plating as is now common practice;

2 The depth of copper plating required for ordinary work is not over 0.0002 in., or with a 100 per cent safety factor, 0.0004 in., and very often a lesser thickness would be sufficient.

THE ENGINEERING INDEX

(Title Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press. At the end of the year the monthly installments are combined and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents each, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Industrial

Industrial Accidents. Monthly Labor Rev., vol. 10, no. 6, June, 1920, pp. 151-165, 4 figs. Notes on influence of war on accident rates in iron and steel industry, 1914-1919, from a bulletin in preparation by Bur. of Statistics; coal-mine accidents in United States in six months ending Jan., 1920; and metal-mine accidents in United States during 1918.

Industrial Poisons

Industrial Poisons. Monthly Labor Rev., vol. 10, no. 6, June, 1920, pp. 166-170. Consideration of poisonous properties of tellurium, based upon 13 cases examined and upon experimental work, together with bibliography of subject. Hexamethylene-tetramine as a poison in rubber industry, and industrial blood poisons in aniline manufacture are discussed.

ACETYLENE

Explosion Prevention

Beechwood as Porous Permeable Material for Acetylene as Means of Preventing Back Travel of an Explosion (Buchenholz als poröser Durchgangsstoff für Acetylen als Mittel zur Verhinderung des Ruckschreitens einer Explosion). Acetylen, vol. 23, no. 1, Jan., 1920, pp. 2-4. Refers to an acetylene generator constructed by firm of J. Rössler, Carlsruhe, by use of which danger of explosion is eliminated by compelling the acetylene to pass through the pores of a beechwood block under its own pressure.

Generators

A New Acetylene Generator for Large Output (Ein neuer Acetylenentwickler für grosse Leistungen). Acetylen, vol. 23, no. 1, Jan., 1920, pp. 1-2, 1 fig. Apparatus constructed by the Sirius Autogenous Works, Ltd. in Eller, for manufacture of products requiring large quantities of acetylene.

AERODROMES

United Kingdom

Aerodromes for Civil Use. Aeronautics, vol. 19, no. 355, Aug. 5, 1920, pp. 121-123. List giving aerodromes and landing grounds open to civil aviation in United Kingdom and location of service and civil stations which are available to civil aircraft in case of emergency.

AERODYNAMICS

Testing Station

Model Aerodynamic Testing Station in Göttingen (Die Modell-Versuchsanstalt für Aerodynamik in Göttingen), L. Prandtl. Zeitschrift für Flugtechnik u. Motoluftschiffahrt, vol. 11, no. 6, Mar. 31, 1920, pp. 84-87, 4 figs. New building is of reinforced concrete equipped with a traveling crane and containing a wind tunnel of reinforced concrete, placed in vertical position, arrangement being copied from the Eiffel plant in Paris, with certain changes. A 300-hp. d.c. motor serves as drive for blower. Testing devices are mounted on car wheels and can be easily moved about on track.

AERONAUTICAL INSTRUMENTS

Flight Indicators

Aerial Flight Indicators (Flugzeug-Steuerzeiger), A. Neuburger. Verkehrstechnik, no. 4, Feb 5, 1920, pp. 51-53, 4 figs. Design and operation of apparatus developed by Director Drexler of the Gyroscope Construction Co., Ltd., which indicates deviations from direct flight, records inclination, radius and direction of traveled curve, and at same time, actual speed and height above earth surface.

Pitot-Static Tube

Comparison of U. S. and British Standard Pitot-Static Tubes, A. F. Zahm and R. H. Smith. National Advisory Committee for Aeronautics, Report No. 81, 4 pp., 6 figs. Test showed that air speed readings of the two instruments are identical to the accuracy of indication of either instrument.

Rate-of-Climb Indicators

Rate-of-Climb Indicators. Air Service Information Circular, vol. 1, no. 31, April 13, 1920, 3 pp., 8 figs. Different types of instruments are named and described. Theory of instruments is explained by formulæ.

AERONAUTICS

France

Present Progress of Aeronautics in France (L'état actuel de l'aéronautique en France), Emile Cougault. Génie Civil, vol. 77, no. 1, July 3, 1920, pp. 11-13. Figures comparing characteristics of aeroplanes built in 1914 and in 1919. It is noted, for instance, that greatest speed obtainable on the ground was 130 km. per hr. in 1914 and 240 km. per hr. in 1919; maximum cruising radius with two men on board was 500 km. in 1914 and 2000 in 1919; maximum power was 130 hp. in 1914 and 1000 in 1919.

McCook Field and

McCook Field and American Aeronautics, Leon Cammen. Mech. Eng., vol. 42, no. 8, Aug. 1920, pp. 441-444, 6 figs. Inception of McCook Field and nature of work carried on. Problem of variable-pitch propeller. Development of measuring instruments. Research work in altitude flying. Present and future potentialities of field.

Naval Architecture in

Naval Architecture in Aeronautics, Jerome C. Hunsaker. Flight, vol. 12, nos. 27, and 32, July 1 and Aug. 1, 1920, pp. 692-695, 6 figs., and 866-868, 3 figs. Also Eng., vol. 109, no. 2843, June 25, 1920, pp. 857-860, 9 figs. Gives weight data for machines supposed to represent successful designs of adequate strength and power, eliminating all that are weak structurally or grossly underpowered, etc.; data summarized on charts to furnish guide for use in preliminary design; and general conclusions arrived at with regard to weight. Annual Wilbur Wright lecture at Central Hall, Westminster.

AEROPLANE ENGINES

Benz

Standard Engine Report on the Six-Cylinder Benz Aviation Engine Rated at 200 hp. at 1400 r.p.m. Air Service Information Circular, Eng. Div., Air Service, vol. 1, no. 41, May 8, 1920, 35 pp., 29 figs. It is concluded that performance of engine is good, although not exceptional. Cylinder construction, valve gear, fuel pump, bearing, cooling, and methods used to obtain compactness could well be applied to American service engines.

Design

Best Density of Cylinder Charge for Aeroplane Engines (Sur le choix de la densité de remplissage dans la conception des moteurs d'aviation à explosions), Jean Villey. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 25, June 21, 1920, pp. 1484-1486. General considerations of engine design for high-altitude flying.

Hispano-Suiza

Standard Report on the 300-hp. Hispano-Suiza Aviation Engine with Steel Cylinders. Air Service Information Circular, Eng. Div., Air Service, vol. 1, no. 64, May 29, 1920, 14 pp., 10 figs. Tests could not be carried to satisfactory conclusion because of lack of parts, but indicated that power is less and fuel economy poorer with this type than with model H.

International Exhibition

The International Aero-Exhibition. Eng., vol. 110, no. 2847, July 23, 1920, pp. 106-109 and p. 118, 9 figs. partly on 2 supp. plates. Types of engines exhibited. (Continuation of serial.)

Isotta-Fraschini

The Italian 6-Cylinder 160-Hp. Isotta-Fraschini Aeroplane Engine (Der italienische 6-Zylinder 160 PS Isotta-Fraschini-Flugmotor), Alfred Staribacher. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 10, nos. 17, 18, 19, 21, 22, 23-24, Sept. 27, Oct. 15, Nov. 15, 29 and Dec. 27, 1919, and vol. 11, nos. 1 and 3, Jan. 15 and Feb 14, 1920, pp. 189-193, 204-208, 234-236, 255-261, 270-271, 6-7 and 40-42, 56 figs. Detailed description of engine and its parts, with specifications.

Maybach

The 260 Hp. Maybach Aero and Dirigible Engine (Der 260 PS Maybach-Flug- und Luftschiffmotor), Otto Schwager. Motorwagen, vol. 23, nos. 6 and 7, Feb. 29 and Mar. 10, 1920, pp. 107-112 and 130-137, 26 figs. 13 on supp. plate. Account of development of Maybach engine. Detailed specifications are given in tabular form of 260-hp. type MbIVa, a 6-cylinder stationary motor with 180 mm. stroke and 165 mm. bore, 1400 r.p.m.; weight, empty, 400 kg. (To be continued.)

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Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ENGINEERING INDEX (Continued)

New Type

New Airplane Engine Designed for Commercial Work. Automotive Industries, vol. 43, no. 5, July 29, 1920, pp. 204-205, 3 figs. Six-cylinder vertical type in which elimination of small parts and accessibility are said to be special features.

Packard

The Packard 500-600 hp. Aircraft Engine. Aviation, vol. 8, no. 12, July 15, 1920, pp. 470-472, 5 figs. Twelve-cylinder engine, weighing 1.94 lb. per hp., and with water, piping and radiator 2,275 per hp., claimed to be lightest in proportion to its power of any standard engine. Actual weight with propeller hub, carburetor, generator and ignition equipment is 1118 lb.

Radiators

Effects of Nature of Cooling Surface on Radiator Performance, S. R. Parsons and R. V. Kleinschmidt. Nat. Advisory Committee for Aeronautics, report no. 87, 1920, 13 pp. 7 figs. Among results obtained were that heat transfer is practically unaffected by light coating of clean oil on smooth surface, that pressure gradient is practically independent of roughness of surface over considerable range, that head resistance of radiator may be somewhat increased by polishing surfaces, as well as flow of air through core of radiator. It is specially emphasized that cooling surfaces and radiators should be kept clean.

Properties of Special Types of Radiators, S. R. Parsons. National Advisory Committee for Aeronautics. Report no. 86. 16 pp., 24 figs., 3 on supp. plates. Investigation conducted for National Advisory Committee for Aeronautics at Bureau of Standards.

Rolls-Royce

The Rolls-Royce Aircraft Engines Described and Illustrated. Automotive Industries, vol. 43, nos. 5, 6 and 7, July 29, and Aug. 5 and 12, 1920, pp. 210-214, 18 figs., 261-265, 12 figs., 316-320, 11 figs. Detailed description of larger size of Eagle type Rolls-Royce engine: 12-cylinder "V" type, with a bore of 114 and a stroke of 165 mm., output 352 hp., and 1650 to 1800 r.p.m. Translated from Der Motorwagen.

Supercharged and Over-Dimensioned

The Design of Supercharged and Over-Dimensioned Aircraft Motors. Aeronautics, vol. 19, no. 355, Aug. 5, 1920, pp. 118-119, 3 figs. Method of calculating dimensions of an over-dimensioned and supercharged motor. Translated from Technische Berichte.

Superchargers

Superchargers for Airplane Engines, Sanford A. Moss. Am. Mach., vol. 53, no. 8, Aug. 19, 1920, pp. 345-348. Treats of aeroplane-engine development showing value of supercharger for high altitude flying.

See also AEROPLANES, International Exhibition.

AEROPLANE PROPELLERS

Design

Approximating Bending Moments in Air Propellers, Edward P. Warner. Aviation, vol. 8, no. 11, July 1, 1920, pp. 430-431, 2 figs. Describes method which, it is claimed, has been found to give results of quite surprising accuracy. In order to permit analytical determination of bending moments, load-grading curve was assumed to be made up of three straight lines and parabola.

Pitch and Climbing Capacity

The Aeroplane in Diagram (Das Flugzeug in Diagramm), H. Schuster. Luftfahrt, vol. 24, nos. 3 and 4, Mar. and Apr., 1920, pp. 41-43 and 60-61, 2 figs. Points out influence of propeller pitch on climbing capacity of aeroplane. Shows by diagram that propeller with large pitch is favorable for speed, and one with small pitch for climbing capacity of machine, and that choice of pitch must be made accordingly.

Theory of

New Theory of the Screw Propeller, M. A. S. Riach. Aeronautics, vol. 19, no. 354, July 29, 1920, pp. 98-100, 1 fig. Theory refers to "static" case of V-O.

AEROPLANES

All-Metal

Experiences in the Construction of Metal Aeroplanes (Eigene Arbeiten auf dem Gebiete Metall-Flugzeugbaues), H. Junkers. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 3, Feb. 14, 1920, pp. 35-37, 7 figs. Writer explains why metal was employed for construction of the Junkers aeroplanes and gives reasons why it is perhaps advisable to employ metal in place of wood.

British

The Air Ministry Competition at Martlesham. Flight, vol. 12, no. 32, Aug. 5, 1920, pp. 855-861, 13 figs. Mechanical details of machines entered.

Dayton-Wright

Report of Static Test on DH-4 (Dayton-Wright) Tail Surfaces. Air Service Information Circular, vol. 1, no. 23, Mar. 31, 1920, 7 pp., 4 figs. Elevator, stabilizer, and rudder satisfactory. Fin not tested but held on previous tests and is regarded safe.

Report of Static Test of the Fuselage of the D.H.-4 (Dayton-Wright). Air Service Information Circular, Eng. Div., Air Service, vol. 1, no. 34, May 8, 1920, 1 p., 6 figs. Test showed fuselage to be satisfactory, holding a load factor of 5.

Design

The Structural Analysis and Design of the Aeroplane, B. C. Boulton. Aerial Age, vol. 11, nos. 22 and 23, Aug. 9 and 16, 1920, pp. 742-744, 10 figs., and 775-777, 4 figs. Calculations of internal stresses in members of structure. Formulæ for designing structural members made of wood and steel in combinations. (Continuation of serial.)

Detection of

Seeing in the Dark. Sci. Am., vol. 123, no. 7, Aug. 14, 1920, pp. 154 and 166-168, 5 figs. Thermopiles and holders for detecting aeroplanes in the dark.

Gallaudet

The Gallaudet C-3 Liberty Tourist Plane. Aerial Age, vol. 11, no. 23, Aug. 16, 1920, p. 771, 3 figs. Dimensions: Length overall, 29 ft. 5 in.; wing span, 44 ft.; height, 10 ft. 3 in.; wing area 48 sq. ft.; weight loaded, 3800 lb.; cruising radius, 500 miles; ceiling, 18,000 ft.; maximum speed, 125 m.p.h. Built by Gallaudet Aircraft Corporation, East Greenwich, R. I.

International Exhibition

The International Aero Exhibition. Eng., vol. 110, nos. 2846 and 2848, July 16 and 30, 1920, pp. 74-79 and p. 82, 12 figs., and 137-142, 8 figs. Details of models exhibited and of Clergat and Zeitlin engines.

Lincoln Standard Speedster

The Lincoln Standard Speedster. Aerial Age, vol. 11, no. 22, Aug. 9, 1920, pp. 740-741, 5 figs. Characteristics: Length overall, 25 ft. 8 in.; height overall, 10 ft.; span, 32 ft.; chord, 6 ft.; weight loaded, 2150; hp. 150 or 180 Hispano-Suiza; climb, loaded, 5000 ft. in 10 min.; speed, maximum, 107 m.p.h.

Profile for Given Lift

Theory of the Lift of Supporting Planes (Zur Theorie des Tragflächenauftriebes), R. v. Mises. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, nos. 5 and 6, Mar. 15 and 31, 1920, pp. 68-73 and 87-89, 14 figs. Writer seeks to find suitable profile forms for given lift conditions. Notes on size and position of lifting force, parameter of profile, and the Joukowski form of profile. It is concluded that the reduction of camber as well as increase of thickness and of edge angle have a favorable effect on movement of pressure center. Examples of profiles with pressure centers are given.

Rib Construction

Tests with a Special Rib Construction (Versuche mit einer besonderen Holmkonstruktion), Karl Balaban. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 6, Mar. 31, 1920, pp. 81-84, 8 figs. Describes a tongued-and-grooved joint used and gives results of experiments with ribs so constructed.

Stalling of

The Dangers and Effect of Construction on Stalling (Der uberzogene Flug, seine Gefahren und seine Beeinflussung durch die Konstruktion), H. Hopf. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 4, Feb. 28, 1920, pp. 52-54, 4 figs. Construction of plane is said to affect stalling in two ways: (1) An aeroplane becomes more readily stalled as difference becomes less between its usual speed and speed at which equilibrium of vertical force is no longer possible; (2) aeroplane comes more readily out of stalling as turning in space becomes easier and the more it is possible to check turning of flight path.

Struts

Effect of Surface Quality of Struts on Aeroplane Resistance (Der Einfluss der Oberflächenbeschaffenheit auf den Widerstand, untersucht an Streben), C. Wieselsberger. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 4, Feb. 28, 1920, pp. 54-57, 8 figs. Curves are given showing results of tests on thick struts covered with linen and with a single coat of varnish. Third report from the Göttingen Model Experimental Station for Aerodynamics.

The Efficiency of Airplane Struts, Wallace F. Wiley. Aviation, vol. 8, no. 12, July 15, 1920, pp. 477-478, 3 figs. General equation for power absorbed by a strut of any material, section, length and strength at any velocity. Application of equation exemplified.

Wings

Report of Static Test of D.H. 4 (P. 34) Wing Cellule. Aid Service Information Circular, Eng. Div., Air Service, vol. 1, no. 36, May 8, 1920, 2 pp., 5 figs. Test showed that with proper maintenance and repair of damage, strength of the wing structure will not be materially reduced by long service.

The "Alula" Wing. Flight, vol. 12, no. 32, Aug. 5, 1920, pp. 862-863, 2 figs. Wing is characterized by very high maximum lift with maximum L/D of about 22.9. Design with such wing and intended for carrying heavy loads at moderate speeds is suggested.

[See also AERONAUTICS; AIRCRAFT, Undercarriages; AVIATION; FLYING BOATS; SEAPLANES.]

AIRCRAFT

Undercarriages

Aircraft Undercarriages, John D. North. Aeronautical Jl., vol. 24, no. 110, Feb., 1920, pp. 39-73 and (discussion) 73-84, 39 figs. Some of points indicated are: Wheel "strain energy" is negligible; shock absorbing capacity increases with rate of loading; energy dissipated (hysteresis) increases with rate of loading, etc.; solid or cushion tires may be used with advantage to reduce oscillations: even tensioning and consistent quality of material are important, and individual rings seem to give best promise of fulfilling these requirements; shock absorbing capacity remains constant with varying rate of loading, and energy dissipated diminishes with rate of loading.

AIRSHIPS

Chalais-Meudon

The Chalais-Meudon Airship C. M. 5. Automotive Industries, vol. 43, no. 5, July 29, 1920, p. 219, 1 fig. Description of airship built by French Government for U. S. Navy, now purchased by Goodyear Tire and Rubber Co.

R.80

H. M. Airship "R.80." Eng., vol. 110, no. 2848, July 30, 1920, pp 142-145 and p. 150, 27 figs. partly on 4 supp. plates. Dimensions: Overall length of hull, 529 ft. without mooring attachment; gas capacity, 1,250,000 cu. ft., giving gross displacement of 38.25 tons of which 17.8 tons is disposable lift. Section of hull is uniform polygon having 21 sides, and diameter of circumscribing circle at largest part is 70 ft. 7½ in. Overall height of ship from bottom of bumping bags on cars to top of hull is 86 ft. 5 in. when axis is horizontal. Ship is propelled at maximum speed of 65 m.p.h. by four engines carried in three cars suspended from hull structure and developing 1000 h.p. at full power. Range at full power is 3900 miles and at normal power 4500 miles.

Schütte-Lanz

The Importance of the Schütte-Lanz Dirigibles (Die Bedeutung der Schütte-Lanz-Luftschiffe), D. Rühl. Luftfahrt, vol. 24, no. 3, Mar. 4, 1920, pp. 38-40, 6 figs. Details of various models and table giving most important data of the characteristics of Schütte-Lanz dirigibles. Attributes present-day high efficiency and degree of perfection of rigid type of dirigible to adoption of form of minimum air resistance, to simple steering gear, elastic suspension of nacelle, etc.

ALLOYS

Electrical Melting

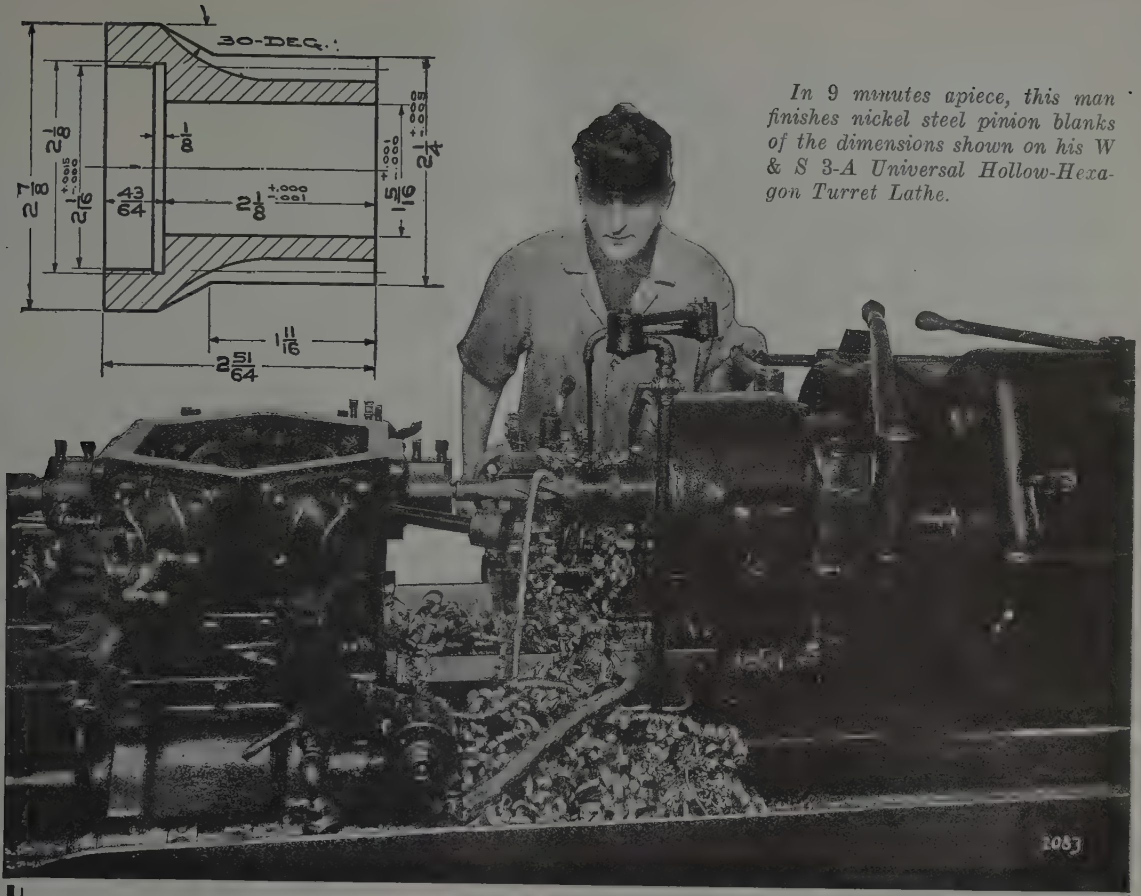
Electrical Melting of Alloys—XI and XII, H. W. Gillett. Foundry, vol. 48, nos. 15 and 16, Aug. 1 and 15, 1920, pp. 612-614 and 656-658, Aug. 1. It is observed that essential points which influence efficiency of operations require installation of electric furnaces under expert supervision. Refractories are discussed. Aug. 15. It is pointed out that efficient operation is measured by continuity of output, as more power is needed per ton melted when furnace cools between heats. It is also noted that cost per kilowatt hour is lower in large installations.

Impact Tests

Study of Impact Tests on Alloys, Austin B. Wilson. Foundry, vol. 48, no. 352, Aug. 1, 1920, pp. 616-617 and 622, 3 figs. Tests made on impact-shear machines and on alternating-impact testers indicated relative value of various alloys. Machining of bars found to be unnecessary for impact-shear test.

Non-Ferrous, Standards for

New Standards for Metals. Metal Industry (N. Y.), vol. 18, no. 8, Aug., 1920, pp. 349-350. Reports on composition and nomenclature of non-ferrous alloys at 1920 meeting of Am. Soc. for Testing Matls.


30-DEG.
$2\frac{7}{8}$
$2\frac{1}{8}$
$2\frac{1}{16}$ +.0015 −.000
$\frac{1}{8}$
$\frac{43}{64}$
$2\frac{1}{8}$ +.000 −.001
$1\frac{5}{16}$ +.001 −.000
$2\frac{1}{4}$ +.009 −.000
$1\frac{11}{16}$
$2\frac{51}{64}$
1083

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ENGINEERING INDEX (Continued)

ALUMINUM

Industry, Germany

The Aluminum Industry in Germany During and After the War (L'industrie de l'aluminium en Allemagne pendant et après la guerre), M. L. Descroix. Revue de Métallurgie, vol. 17, no. 4, April 1920, pp. 275-285. Economical study based on data published in German periodicals.

Welding of

Autogenous Welding of Aluminum (Autogene Aluminiumschweissung), H. Pradel. Elektrotechnischer Anzeiger, vol. 37, no. 30, Feb. 21, 1920, p. 139. Describes process developed by the Griesheim-Elektron chemical factory in Frankfurt, according to which aluminum can be welded in any form as casting, plate or wire with the aid of a liquid for dissolving the aluminum oxide layer.

ALUMINUM ALLOYS

Specific Gravity and Composition

The Relationship Between Specific Gravity and Composition of Light Aluminium Alloys, B. W. Hales. Engr., vol. 129, no. 3357, April 30, 1920, pp. 439-440, 2 figs. Results of comparative tests. Reference is made to paper by Rhodin read before Faraday Soc. in July 1918.

[See also DURALUMIN.]

ALUMINUM CASTINGS

Defects Causing Losses

Casting Losses in Aluminum-Foundry Practice in the United States, Robert J. Anderson. Metal Industry (New York), vol. 18, no. 7, July 1920, p. 318. Report of an investigation for Bur. of Mines, Department of Interior, giving defects causing losses, monetary values of losses, etc.

ANNEALING OVENS

Continuous

New Annealing Oven Saves Heat. Foundry, vol. 48, no. 351, July 15, 1920, pp. 569-570, 3 figs. Continuous tunnel kiln having double chambers with a common wall between is said to reduce radiation surface. Cold cars enter one chamber and absorb heat of cars coming from opposite chamber.

ANTIMONY

Crystalline Structure

The Crystalline Structure of Antimony, R. W. James and Norman Tunstall. London, Edinburgh & Dublin Philosophical Mag. & Jl. of Science, vol. 40, no. 236, Aug. 1920, pp. 233-239, 2 figs. Observations are related from which it appears that assumption for antimony of structure similar to that of diamonds (see Philosophical Mag. 1914, p. 224) will not explain spectra observed from various phases of crystalline structure.

APPRENTICES, TRAINING OF

Electric Welders

Training Electric Welders. Machy. (N. Y.), vol. 26, no. 12, Aug. 1920, pp. 1142-1145, 4 figs. Methods used by General Electric Co., Schenectady, N. Y., in training operators of electric welding equipment.

Santa Fe System

The Santa Fe Apprentice System, F. W. Thomas. Jl. Western Soc. of Engrs., vol. 25, no. 11, July 20, 1920, pp. 404-410. History of introduction and details of organization of system for training of employees in the railway shops.

ASBESTOS

Use in Paint Industry

The Use of Abestos in the Paint Industry, G. B. Heckel. Contract Rec., vol. 34, no. 31, Aug. 4, 1920, pp. 741-742. Discussion of functions of reinforcing pigments. Formula for fire-retardant paint.

AUTOMOBILE ENGINES

Design

Engine Design for Maximum Power and Economy of Fuel, C. A. Norman. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 182-185, 2 figs. Influence of air heating on power, delayed combustion, supercharging, etc.

Intake-Manifold Temperatures

Intake-Manifold Temperatures and Fuel Economy, W. S. James, H. C. Dickinson, and S. W. Sparrow. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 131-137, 11 figs. It is concluded (1) that at constant speed, mixture ration, and power output, fuel consumption in lb. per b. hp, is independent of temperatures and methods of heating the intake charge within the range tested; and (2) the rate at which an engine will accelerate with a given mixture ratio, or carburetor setting, is markedly affected by amount of heat supplied and its method of application.

Radiators

Ford Motor Radiator, Fitted with Deane Tubes. Engr., vol. 129, no. 3358, May 7, 1920, p. 484, 3 figs. Tubes are not soldered to top and bottom tanks, but can be readily and quickly removed and replaced either one by one or in numbers.

AUTOMOBILE FUELS

Alcohol-Benzol Mixtures

Alcohol-Benzole Mixtures. Motor Traction, vol. 30, no. 798, June 14, 1920, p. 572, 1 fig. Results of experiments made by London Gen. Omnibus Co. with 50 per cent mixture of alcohol and benzol are said to show the slight superiority of gasoline in respect of miles per gal.

Heavy Fuels

Notes on the Use of Heavy Fuel in Automotive Engines, H. M. Crane. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 147-148. Discusses briefly fuels of different grades and design requirements to secure good results.

Gasoline vs. Kerosene

Comparison of Kerosene and Gasoline for Heavy Duty Engines, P. S. Tice. Automotive Industries, vol. 43, no. 3, July 15, 1920, pp. 111-113, 5 figs. Results of several tests. It is concluded that carburetor and manifold changes would make present engine suitable for heavier fuels.

AUTOMOBILES

Propeller-Operated

"Helica"—An Automobile Operated by a Propeller (L'Hélica ou voiture a hélice), E. Weiss. Nature (Paris), no. 2409, June 5, 1920, pp. 305-308, 5 figs. Body of car designed along lines of fuselage. Four-bladed propeller rotated by 8-hp. two-cylinder V-engine imparts motion to car.

Transmissions

The Strength of Cardan-Shafts, A. Johnson. Automobile Engr., vol. 10, no. 140, July 1920, pp. 266-267, 2 figs. Bending moment and critical length of a shaft is worked out by formulae.

[See also GEARS, Automobile.]

AVIATION

Altitude, Effects of

Some Physical and Psychical Effects of Altitude, Charles Atkin Swan. Aeronautical Jl., vol. 24, no. 109, Jan. 1920, pp. 3-10 and (discussion), pp. 10-14. Writer seeks to prove that most persons can take advantage of aviation as means of transport, and that as they get over seasickness, there is no reason why they should not get over airsickness. Various different conditions which take place at high altitudes, such as low pressure and partial oxygen pressure, etc., are considered.

London-Paris Service

Aerial Service between London and Paris (Les transports aériens entre Paris et Londres). Génie Civil, vol. 76, no. 26, June 26, 1920, pp. 577-578. Records of passenger traffic from Aug. 25, 1919, to June 2, 1920. Total of 1641 passengers and 38,860 kg. of merchandise were transported during that time.

Naval Air Station, Pensacola

The Naval Air Station at Pensacola, Fred H. Colvin. Am. Mach., vol. 53, no. 5, July 29, 1920, pp. 197-199, 3 figs. Description of equipment.

Releasing Lift

Some Kite-Balloon Experiments, Griffith Brewer. Aeronautical Jl., vol. 24, no. 109, Jan., 1920, pp. 16-32 and (discussion), pp. 32-36, 16 figs. Account of experiments made with a Drachan balloon to ascertain best method of placing at pilot's disposal the power of suddenly releasing about 500 lb. of lift. Writer describes his invention which forms subject of secret patent which he assigned to the Admiralty, and is published with permission of Admiralty.

[See also AERODROMES, AEROPLANES.]

B

BALLOONS

Fabrics for, Ignition Liability

The Liability of Ignition of Balloon Fabrics, Guy Barr. Aviation, vol. 8, no. 11, July 1, 1920, pp. 435-436. Describes tests undertaken to ascertain (1) whether fabric B. 29, a fabric of treble cotton and rubber and doped on exterior with aluminum dust suspended in "soluble gun-cotton," is liable to become ignited owing to gunfire and result of a smouldering wad falling on it; (2) best fire-proofing material to employ to prevent fabric becoming ignited, and effect of this material on strength and permeability of fabrics, both when new and after weathering.

BARGES

Concrete vs. Steel

The Consumption of Power in the Towing of Steel and Reinforced-Concrete River Lighters (Der Kraftverbrauch bei der Schleppung von Flussleichtern aus Eisen und Eisenbeton), Gerhard Neumann. Beton u. Eisen, vol. 19, no. 4-5, Mar. 4, 1920, pp. 49-52, 2 figs. Table is given showing saving of power effected by use of concrete boats instead of under-frame steel barges, in addition to economy in steel and in coal required for fuel.

BEARINGS, BALL

Three-Area Contact

Manufacturing Three-Area Contact Ball Bearings, Fred R. Daniels.—I. Mach. (N. Y.), vol. 26, no. 12, Aug. 1920, pp. 1107-1111, 10 figs. Description of manufacturing, inspection and assembling methods used in shops of Federal Bearings Co., Inc., Poughkeepsie, N. Y.

BEARINGS, ROLLER

Tests

Test of Large Roller Bearings Under Heavy Loads, G. M. Barnes. Am. Mach., vol. 53, no. 5, July 29, 1920, pp. 200-201, 2 figs. Tests conducted by U. S. Ordnance Department.

BENZENE

High-Temperature Reactions with Toluene

Some High-Temperature Reactions of Benzene and Toluene, S. F. Dufton and John W. Cobb. Gas World, vol. 72, no. 1872, June 5, 1920, pp. 485-488. Experimental. Benzene passed through heated column of coke with time of contact of about 12 seconds began to undergo molecular condensation in an inert gas at about 500 deg. cent. with elimination of hydrogen, first product being diphenyl. At 750 deg. cent. action was much more extensive and more complex. At 920 deg. cent. free carbon was produced in quantity.

BLAST FURNACES

Flue Dust Briquetting

The Development of Flue Dust Briquetting, Albert L. Stillman. Blast Furnace and Steel Plant, vol. 8, no. 7, July 1920, pp. 395-398, 3 figs. Process is believed to offer efficient treatment, simple mechanism and low cost for recovery of iron from flue dust.

Performance

Charts for Computing Blast-Furnace Performance, Harold L. Fickett. Eng. and Min. Jl., vol. 110, no. 3, July 17, 1920, pp. 108-109, 2 figs. Graphical determination of slag production, matte fall, and tonnage smelted per sq. ft. Methods used at Copper Queen Smelter.

Reactions in

Contributions to the Study of the Reactions in Connection with Blast-Furnace Equilibrium (Beiträge zur Kenntnis der Reaktionen beim Hochofengleichgewicht), Ernst Terres and Aurel Pongracz. Zeitschrift für Elektrochemie, vol. 25, no. 23-24, Dec. 1, 1919, pp. 386-407, 13 figs. Supplement to investigations for determination of different equilibria of the reactions between iron or its oxides and CO_2, CO, steam and hydrogen, and investigation of changes in solid and gas phases for purpose of clearing up differences between present and previous work.

BOILER EXPLOSIONS

Gas Explosion in Flues

Steam Boiler Explosion in the Augustiner Brewery in Munich (Dampfkesselexplosion in der Augustinerbrauerei zu München), K. Graf. Zeitschrift des Bayerischen Revisions-Vereins, vol. 24, no. 6, Mar. 31, 1920, pp. 41-44, 6 figs. It is demonstrated that accident was due to a gas explosion in the flues of the boiler, and the mud collector probably exploded before it broke loose from boiler. Gives conditions prescribed for the re-installation of boiler.

BOILER FEEDWATER

Treatment

Progress in the Purification of Boiler Feedwaters (Fortschritte in der Reinigung von Kesselspeisewassern), D. B. Preu. Zeitschrift für angewandte Chemie, vol. 33, nos. 22 and 24-25, Mar. 16 and 26, 1920, pp. 61-63 and 70-72, 1 fig. Discusses various purification

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methods and apparatus and points out their defects, many of which, it is claimed, are eliminated by application of the Neckar water-purification process with use of apparatus constructed by P. Müller Co., Ltd., Stuttgart, consisting of a purification tank with built-in drop pipe, filter and sludge collector with sludge-discharging device, which is connected with a second tank for refiltration provided with similar equipment.

BOILER FIRING

See OIL FIRING, White System.

BOILER OPERATION

Combustion Control

Combustion-Control Apparatus for the Boiler Room (Verbrennungs-Kontrollapparate für das Kesselhaus). Der Praktische Maschinen-Konstrukteur, vol. 53, no. 11, Mar. 18, 1920, pp. 91-96, 9 figs. Details of the Ados apparatus which is claimed to so record CO_2 percentage content of combustion gases that with the use of a table it is possible to determine extent of fuel loss; and the Mono combustion-control apparatus, designed by H. Maihak Co., Inc., Hamburg, consisting of an absorption apparatus and recording instrument enclosed in a dust-proof cast-iron case, the door of which has a glass pane at the top through which the record of previous ten hours is visible, and which even in case of 50 analyses per hr. is said to give perfect results.

Efficiencies at High and Low Ratings

Developing High Overload Capacities. Power House, vol. 13, no. 15, Aug. 5, 1920, pp. 356-357 and p. 360, 4 figs. Particulars of tests run on water-tube boiler with horizontal baffling to determine efficiencies at high and low ratings.

BOILERS

Air Leakage Through Settings

CO_2 Exploration to Detect Air Leakage, A. E. Grunert. Power, vol. 52, no. 2, July 13, 1920, pp. 54-56, 3 figs. Method of exploration for detecting air leakage and giving CO_2 conditions throughout boiler setting is presented. Its use in cases cited so reduced air infiltration that final overall efficiencies of 81 to 83 per cent were obtained.

Corrosion

Corrosion in Locomobile Boilers and Its Prevention (Anfressungen an Lokomobilkesseln und ihre Bekämpfung), H. Reichelt. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 11 and 12-13, Mar. 12 and 26, 1920, pp. 81-82 and 90-92, 12 figs. Describes typical corrosions occurring in boilers with suspended fireboxes after prolonged operation and careless attendance; and in boilers with cylindrical fireboxes and removable pipe system. A graphite-tar coating is recommended for outside of smokebox tube wall and for firebox base in boilers with suspended firebox.

Electrically Heated

Electrically Heated Steam Boilers and Heat-Storage Tanks (Ueber elektrisch geheizte Dampfkessel und Wärmespeicher), E. Höhn. Zeitschrift des Bayerischen Revisions-Vereins, vol. 24, nos. 6 and 7, Mar. 31 and Apr. 15, 1920, pp. 44-46 and 50-52, 13 figs. Discussion of electrode boilers and hot-water storage for generation of steam. Description of heat storage by means of oil, by concrete and hot water with heat transmission by oil, and with tube evaporators. Notes on hot-water heating, and economic problems in connection with conversion of electric current into heat. Address before Swiss Soc. of Steam Boiler Masters. (Concluded.)

Horizontal Baffling

Boiler Plant Practice. Refrigerating World, vol. 55, no. 7, July 1920, pp. 21-23, 4 figs. Tests conducted on one unit of installation of boiler plant to ascertain whether arrangement of horizontal baffling suitable for attaining high capacities would prejudice efficiencies obtainable at lower ratings.

Tests on Large Horizontally Baffled Boiler. Textile World Jl., vol. 58, no. 6, Aug. 7, 1920, pp. 115-117, 4 figs. Tests conducted on boiler unit to ascertain whether arrangements of horizontal baffling suitable for attaining high capacities would prejudice efficiencies obtainable at lower ratings. High overload capacities were obtained with type of boiler and arrangement of baffles used.

[See also STEAM GENERATORS.]

BOILERS, WATER-TUBE

Vertical

Investigations of Vertical Water-Tube Boilers (Untersuchungen an Steilrohrkesseln), Friedrich Münzinger. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 21-22, 23-24 and 25, May 29, June 12 and 19, 1920, pp. 393-398, 432-433 and 453-457, 24 figs. Based on investigation of the seven types installed at the Golpa central power station, certain ideas for construction of large steam boilers for low-grade lignite are developed, followed by discussion of a method for calculation of the water circulation in double-headed and vertical water-tube boilers.

BORING MILLS

Vertical

A New Vertical Boring and Turning Mill. Eng. Production, vol. 1, no. 7, July, 1920, p. 258, 2 figs. Details of latest Wilkinson 20-in. duplex vertical boring and turning mill with gear-box drive, which is said to permit rapid handling of medium-sized jobs.

BRAKES

Pneumatic vs. Electric

Pneumatic and Electric Brakes (Druckluftbremse und elektrische Bremse), H. Sauveur. Verkehrstechnik, vol. 37, no. 9, Mar. 25, 1920, pp. 126-130 5 figs. Comparison of their relative merits, from which it is concluded that none of the electric brakes possesses the safety of operation of the air brake. Results of tests to determine operation movements in the handling of brakes are shown in illustrations.

Pneumatic vs. Suction

Freight Train Brakes (Zur Bremsung der Güterzüge), E. Cimonetti. Zeitung des Vereins deutscher Eisenhahnverwaltungen, vol. 60, no. 5, Jan. 21, 1920, pp. 53-55. Discussion of the relative merits of the pneumatic and suction air brakes.

BRIDGE DESIGN

Trusses, Riveted Joints in

Detail Design of Riveted Joints of Bridge Trusses, W. M. Wilson. Eng. News-Rec., vol. 85, no. 6, Aug. 5, 1920, pp. 259-260, 2 figs. Riveting determined by study of paths of forces connected. Two examples.

BRIDGES, RAILWAY

Arsta Bay, Sweden

International Competitive Designs for a Railroad Bridge over Arsta Bay Near Stockholm (Wettbewerb zu einer Eisenbahnbrücke über die Arsta-Bucht bei Stockholm), Zentralblatt der Bauverwaltung, vol. 40, nos. 20 and 21, Mar. 10 and 13, 1920, pp. 125-127 and 130-136, 35 figs. Plans call for movable bridge, 600 m. long, opening to width of 24 m. for passage of high-masted ships, with superstructure of iron or concrete, or both. Details and illustrations of the three prize-winning designs and the four designs bought by railroad administration. (Continuation of serial.)

Floors for

Floor for Railway Under-Bridges. Engr., vol. 129, nos. 3355 and 3356, April 16 and 23, 1920, pp. 391-394, 11 figs., and 416-418, 8 figs. Following types are described: single line, double line, and double line with centre girder, longitudinal and concrete.

BRIDGES, STEEL

Design

Stability of Compression Members of Steel Bridges (La stabilité des membrures comprimées des ponts métalliques), M. Keelhoff. Annales des Ponts et Chaussées, vol. 55, no. 2, March-April 1920, pp. 193-231, 27 figs., partly on supp. plate. Suggestions in regard to design of cross bracings. Cases in which they are indispensable.

Rapid Erection

The First Bridge to be Constructed on the Roth Waagner System (Die erstmalige Anwendung der Roth-Waagner-Brücke), R. Feindler. Eisenbau, vol. 11, no. 8, Apr. 23, 1920, pp. 151-156, 8 figs. Details of 470-m. steel truss bridge over Save River, Belgrade, Servia, built according to system developed by Roth & Waagner, Vienna-Budapest, which permits of extremely rapid erection.

Reconstruction

The Reconstruction of the Bridge over the Narew River Near Modlin (Nowo Georgiewsk), Poland (Die Wiederherstellung der Brücke über den Narew bei Modlin). Eisenbau, vol. 11, no. 9, May 4, 1920, pp. 161-185, 36 figs. Three new large superstructures were built in place of old ones with same span of 76.86 m., according to system of parallel beam with alternating rising and falling diagonals and intermediate verticals; height of system, 7.15 m.; bay width, 7.32 m.; width of roadway, 5.m with 1.78-m. sidewalks on either side; weight of steel construction, over 2000 tons. Details of equipment used.

Restoration

Restoration of the Cernavoda-Danube Bridge. Eng., vol. 109, no. 2842, June 18, 1920, pp. 837-840, 19 figs. Restoration by Germans of bridge and viaduct destroyed by Rumanians and Russians.

Solid Web Trusses

The Calculation of the Statically Indeterminate Solid Web Trusses with the Aid of Displacement Diagrams (Zur Berechnung statisch unbestimmter Vollwandbinder mit Hilfe von Verschiebungsplänen), E. Kammer. Eisenbau, vol. 11, no. 5, Mar. 9, 1920, pp. 117-128, 31 figs. Calculation of displacements in bar tensions by determination of vertical and horizontal components. Investigation of frequently occurring special conditions whereby area of influence for statically indeterminate quantity of system is a parabola. Formulae for calculation of horizontal components of displacements given for the case where the equation of the truss of header axis and equation of vertical displacements are known.

BRIDGES, SUSPENSION

Deflection, Reduction of

The Suspension Bridge over the Rio Sapucahy (Brazil) and General Considerations of Suspension Bridge Deflections (Die Hängebrücke über den Rio Sapucahy nebst einigen allgemeinen Bemerkungen über die Durchbiegung von Hängebrücken), A. Müllenhoff. Eisenbau, vol. 11, no. 6, Mar. 23, 1920, pp. 129-137, 9 figs. Account of a statically indeterminate steel cable bridge of 90 m. span with 4.24 m. distance between main girders which are 2.19 m. high. Numerical tables are given for use of designing engineers, as well as general formulae relating to reduction of deflection.

BUSES

Electric Railways vs.

The Place of the Bus—VI, Walter Jackson. Elec. Ry. Jl., vol. 56, no. 5, July 31, 1920, pp. 209-218. Opinion is expressed that at present costs the bus may supplement but cannot, from an economical point of view, supplant the electric railway upon the basis of equal fare and responsibilities.

C

CABLES, ELECTRIC

Faults, Localization of

Localization of Faults in Heavy Current Cables Due to Contact between All Conductors (Die Fehlerortsbestimmung in Starkstromkabeln bei Schluss zwischen allen Leitern), K. de Koning. Elektrotechnische Zeitschrift, vol. 41, no. 13, Apr. 1, 1920, pp. 249-250, 5 figs. It is shown that in this case it is absolutely necessary to obtain an accurate idea of character of disturbance before attempting to locate fault, because otherwise incorrect results may be obtained. Describes method for accurate localization of fault in frequently occurring event that one of the intermediate resistances is large and another is small.

CANALS

Lock Design

General Design of a Lock and Approaches, J. W. LeB. Ross. Jl. Eng. Inst. of Canada, vol. 3, no. 8, Aug 1920, pp. 383-386, 14 figs. Considerations based on records of operation of Canadian canal at Sault Ste. Marie.

Trans-Prussian

The Trans-Prussian Canal (Der Mittellandkanal), H. Sympher. Zentralblatt der Bauverwaltung, vol. 40, no. 16, Feb. 25, 1920, pp. 97-104, 6 figs. In 1918 the Prussian House of Representatives recommended that construction of a through canal from east to west boundary of Prussia be submitted to the Diet. Details with maps of preliminary plans are given, and it is concluded that prospects are favorable for the expansion of the German waterways.

CAPSTANS

Electric

Electric Capstans (Elektrische Spille), Annalen für Gewerbe u. Bauwesen, vol. 86, no. 3, Feb. 1, 1920, pp. 21-22, 3 figs. Details of the Demag electric capstans of which standard models are built with tractive force of 200 to 5000 kg. and for three-phase 50-cycle current or direct current.

CAR WHEELS

Tires

Measurements in Connection with Machining of Car-Wheel Tires (Ueber das Messen bei der Radreifenbearbeitung), O. Jacken. Annalen für Gewerbe u. Bauwesen, vol. 86, no. 3, Feb. 1, 1920, pp. 18-20, 10 figs. Details of devices for measuring outside and inside diameters, for locating seats on axles, and for steady rests on tire lathe, etc., constructed by the Oberschöneweide Machine Factory, Inc.

CARBURETORS

Carburation

A Study in Charge Proportioning with Heavy Fuels, P. S. Tice. Automotive In-

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dustries, vol. 43, no. 6, Aug. 5, 1920, pp. 266-269, 6 figs. Tests with Hinkley engine and heavy-fuel carburetor. Theoretical considerations underlying carburetor operation and means required to meet them under varying conditions of throttling and climate. (Concluded.)

Gasoline-Kerosene

A Petrol-Paraffin Carburetter. Autocar, vol. 45, no. 1291, July 17, 1920, p. 102, 1 fig. Description of instrument which supplies engine with two separate fuels at same time.

Grace

A New Type of Carburetter. Engr., vol. 129, no. 3364, June 18, 1920, p. 620, 6 figs. Patented device said to permit varying strength of mixture over a wide range from control within reach of driving seat. When air-fuel ratio has been once set at any desired value by means of this control, proportionality is claimed to be maintained constant at all throttle openings.

Heavy-Oil

A New Heavy-Oil Carburetor (Ein neuer Schweröl-Vergaser). Motorwagen, vol. 23, no. 7, Mar. 10, 1920, p. 139, 1 fig. Type in which air is brought to a very high temperature through a steel tube nest (heated by exhaust gases) and then transmitted by tube to carburetor.

Mixture-Ratio Tests

Saving Fuel with the Carburetor, W. E. Lay. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 188-189, 2 figs. Mixture-ratio tests made at University of Michigan. Various carburetor operating conditions.

CARDAN SHAFTS

See AUTOMOBILES, Transmissions.

CARS

Boarding, for Lumber Camps

Boarding Cars for Lumber Camps. Ry. Rev., vol. 67, no. 2, July 10, 1920, pp. 39-42, 12 figs. Humbrid Lumber Co., Sandpoint, Idaho, has for boarding of its workmen, three complete trains of camp cars, 37 in all, comprising kitchen, sleeping, commissary, office and dining cars, which are steam heated, electric lighted, etc.

Couplers

The Type "D" Coupler in Passenger Service. Ry. Age, vol. 69, no. 7, Aug. 13, 1920, pp. 285-287, 2 figs. Difficulties involved in its application. How problem was solved on new Pullman cars.

Mine

Notes on a New Type of Colliery Tram, W. D. Woolley. Proc. South Wales Inst. of Engrs., vol. 36, no. 1, July 16, 1920, pp. 165-177, 10 figs. Frame of new design is of oak instead of pitch pine as in the older design and Rowbotham wheels are used instead of fixed wheels.

CARS, FREIGHT

Ammunition, English

British Railway Workshops in War Time XIII. Engr., vol. 129, no. 3356, April 23, 1920, pp. 430-432, 11 figs. Stages in manufacture of limber hooks, coupling links and hinges for munition cars at Stratford works of Great Eastern works.

Concrete

Construction of the First Reinforced-Concrete Car in Austria (Bau des ersten Kohlenwagens aus Eisenbeton in Oesterreich), Walter Stross. Beton u. Eisen, vol. 19, no. 4-5 and 6, Mar 4 and Apr. 8, 1920, pp. 52-54 and 75, 6 figs. Deals with determination of forces acting and calculations involved; connection of reinforced-concrete underframe with running gear, and maintaning prescribed weight. Results of tests of car under overload are said to demonstrate its practical value.

CASTINGS

Metal, Limitations

Metal Castings. Mech. Eng., vol. 42, po. 8, Aug. 1920, pp. 427-439 and (discussion), p. 440, 8 figs. Group of papers on usefulness and limitation of various types of castings contributed by A. S. M. E. Sub-Committee on Foundry Practice. Titles of papers are: Aluminum Castings, by Zay Jeffries; Malleable Castings, by Enrique Touceda; Steel Castings, by John H. Hall; Die Castings, Charles Pack; Brass and Bronze Castings, Christopher H. Bierbaum; Gray-Iron Castings, Richard Moldenke.

CEMENT GUN

Tests

Results of Tests of Strength of Gunite Slabs. Eng. & Contracting, vol. 53, no. 25, June 23, 1920. p. 723, 1 fig. Tables are presented giving summary of tests on gunite slabs, 2 in. thick, 4 ft. clear span; of gunite slabs, simple beam 6 ft. clear span; and gunite slabs of 6 ft. 8 ft. span.

CENTRAL STATIONS

Oil-Burning Engines

Oil-Burning Engines for Central-Station Operation, C. H. Reeder. Elec. Rev. (Chic.), vol. 77, no. 3, July 17, 1920, pp. 77-80, 5 figs. In sizes up to 2000 or 2500 kw. the oil-burning engine, it is stated, is taking its place as a prime mover in generating plants. Equipment is said to be available in many sizes suitable for central-station industry.

Southern Vermont

Interconnection in Southern Vermont—II. Elec. World, vol. 76, no. 2, July 10, 1920, pp. 70-72, 6 figs. Centralization of dispatching function said to be helpful. Graphic analysis of intercompany operations.

United States

Central-Station Capacity Increasing Fast. Elec. World, vol. 76, no. 7, Aug. 14, 1920, pp. 332-334, 2 figs. Statistical data of central-station developments in United States. Total installation of 12,760,900 kw. on Jan. 1, 1920. Gain during 1919 reached approximately 9.8 per cent. Prime movers in central stations total 17,061,600 hp.

CHAIN

Navy Stud Cable

Chain Cable and Some of its Properties, C. G. Lutts. Am. Drop Forger, vol. 6, no. 7, July 1920, pp. 322-326, 9 figs. Material, processes of manufacture, heat treatment and physical properties of power-forged chain as made at Boston Navy Yard.

CHAIN DRIVE

Theory

On Chain Driving Theory, F. M. Lawson. Eng., vol. 110, no. 2844, July 2, 1920, pp. 1-4, 5 figs. Formula and graphs are developed for computing in any case most economical characteristics of chain drive. Results of experimental tests are included.

CHIMNEYS

Reinforced-Concrete

New Concrete Chimney System. Concrete, vol. 17, no. 1, July 1920, pp. 33-34, 4 figs. Coniform monolithic design with series of vertical and integral ribs extending from bottom to top and terminating against base of ornamental top.

CHROME STEEL

Properties

The Properties of Iron-Chromium-Carbon Steels—I, C. A. Edwards, H. Sutton and G. Oishi. Eng., vol. 109, no. 2838, May 21, 1920, pp. 692-694, 8 figs. Account of experiments conducted to determine thermal critical points, especially A1 changes, of iron-carbon-chromium alloys, as revealed when rate of heating or cooling was very slow, and to record effects of varying known rates of cooling and initial temperatures upon carbide changes as well as their influence on hardness of material. Paper read before Iron & Steel Inst.

CHROME-NICKEL STEEL

Brittleness

Brittleness in Nickel-Chrome and Other Steels, F. Rogers. Iron & Steel Inst., advance proof (meeting, May 6 and 7, 1920), 5 pp. 15 figs. 14 on supp. plate. Details in form of tables of analyses and test results, together with some heating and cooling curves in connection with paper read at previous meeting, when detailed data were not ready for presentation.

CHUCKS

Magnetic

Magnetic Chucks. Eng. Production, vol. 1, no. 8, Aug. 1920, pp. 283-288, 40 figs. Their construction and application.

CIRCUIT BREAKERS

Oil Type

Increasing Oil-Circuit-Breaker Capacities, C. J. Hejda. Elec. World, vol. 76, no. 2, July 10, 1920, pp. 67-68, 1 fig. Standard oil breaker, equipped with pressure vents, hollow contact rods and an improved liquid for quenching the arc, said to have shown greatly increased rupturing capacity under actual tests.

CITY PLANNING

See TOWN PLANNING.

CLAYWORKING

Pug-Mill Control

Studies in Pug-Mill Control, H. Spurrier. Jl. Am. Ceramic Soc., vol. 3, no. 5, May, 1920, pp. 388-403, 5 figs. It is shown microscopically that pugging causes a segregation of mineral constituents of a plastic body; method is shown for determination of working pressure of pug-mills.

CLOCKS

Electric

Electric Clocks (Dans l'horlogerie électrique), Léopold Reverchon. Industrie Électrique, vol. 29, no. 671, June 10, 1920, pp. 203-206, 8 figs. Schemes for automatic winding. (To be continued.)

COAL

Briquetting

Some Investigations in Briquetting Oklahoma Coal, J. C. Davis. Chem. and Metallurgical Eng., vol. 23, no. 3, July 21, 1920, pp. 101-102. Tests conducted at Oklahoma University showed that certain Oklahoma soft coals can be successfully briquetted, make cleaner domestic fuel than ordinary bituminous coals, and stand handling and rough usage to a remarkable degree. Abstract from paper presented before chemists and engineers' meeting at Tulsa, Okla.

Carbonization of

The Transition from Coal to Coke, Eric Sinkinson. Jl. Chem. Soc., vols. 117 & 118, no. 693, July 1920, pp. 839-843. Account of experiments on the carbonization of coal from which it was concluded that decomposition of coal begins at 450 deg. cent. and continues to 500 deg. cent., at which temperature sufficient free carbon has been liberated to form conducting bridge in coal.

Distillation of

The Distillation of Coal in Rotating Furnaces (Die Entgasung der Kohle im Drehofen), E. Roser. Stahl u. Eisen, vol. 40, no. 22, June 3, 1920, pp. 741-747, 5 figs. Summarizes results obtained by separation of distillation from gasification in gas-producer operation with recovery of by-products. It is claimed that by extensive recovery of by-products from coal, shales, etc., a great part of heating and lubricating oils used in Germany will, in a few years, be produced from her own coal supplies.

Sampling

Shipping American Coals to Switzerland, with Sampling Methods in Use, Joseph D. Davis. Coal Age, vol. 18, no. 7, Aug. 12, 1920, pp. 334-338, 10 figs. Methods of sampling here and abroad, with information regarding Swiss requirements. Description of handling of coal by Northern, or German, route to Switzerland. Why American coals have difficulty in finding welcome equal to that given to known European fuels.

Spontaneous Combustion

The Constitution of Coal in Relation to its Spontaneous Combustion, F. V. Tideswell. Proc. South Wales Inst. of Engrs., vol. 36, no. 1, July 16, 1920, pp. 183-258, 4 figs. Survey of experimental results found by various investigators. Bibliography of articles on the subject is appended.

COAL GAS

Efficiencies in Use of Different Grades

Efficiencies in Use of Different Grades of Gas. Gas World, vol. 72, no. 1872, June 5, 1920, pp. 488-492. Report of Research Committee of Gas Investigations Committee, Instn. of Gas Engrs. It deals with illuminating power and thermal efficiency attainable with low-pressure upright incandescent burner and different grades of gas.

COAL HANDLING

Retarding Conveyors

Lowering Lump Coal Down a Steep Mountain on a Moving Bed of Slack, Donald J. Baker. Coal Age, vol. 18, no. 2, July 8, 1920, pp. 53-58, 10 figs. Describes what are probably two longest retarding conveyors in the world, at Beard's Fork mine in Fayette County, W. Va.; machines require power to start them, but one, when started, is self-actuating and other approaches that point; save coal from breakage and act as picking tables.

COAL MINING

Stripping

Stripping 85-Ft. Cover from an Anthracite Bed with a Dragline Excavator. Coal Age, vol. 18, no. 2, July 8, 1920, pp. 63-66, 12 figs. Large tonnage will be mined on surface and passed down battery breasts, which will be driven from mine below; coal is to be hauled underground to a breaker for preparation.

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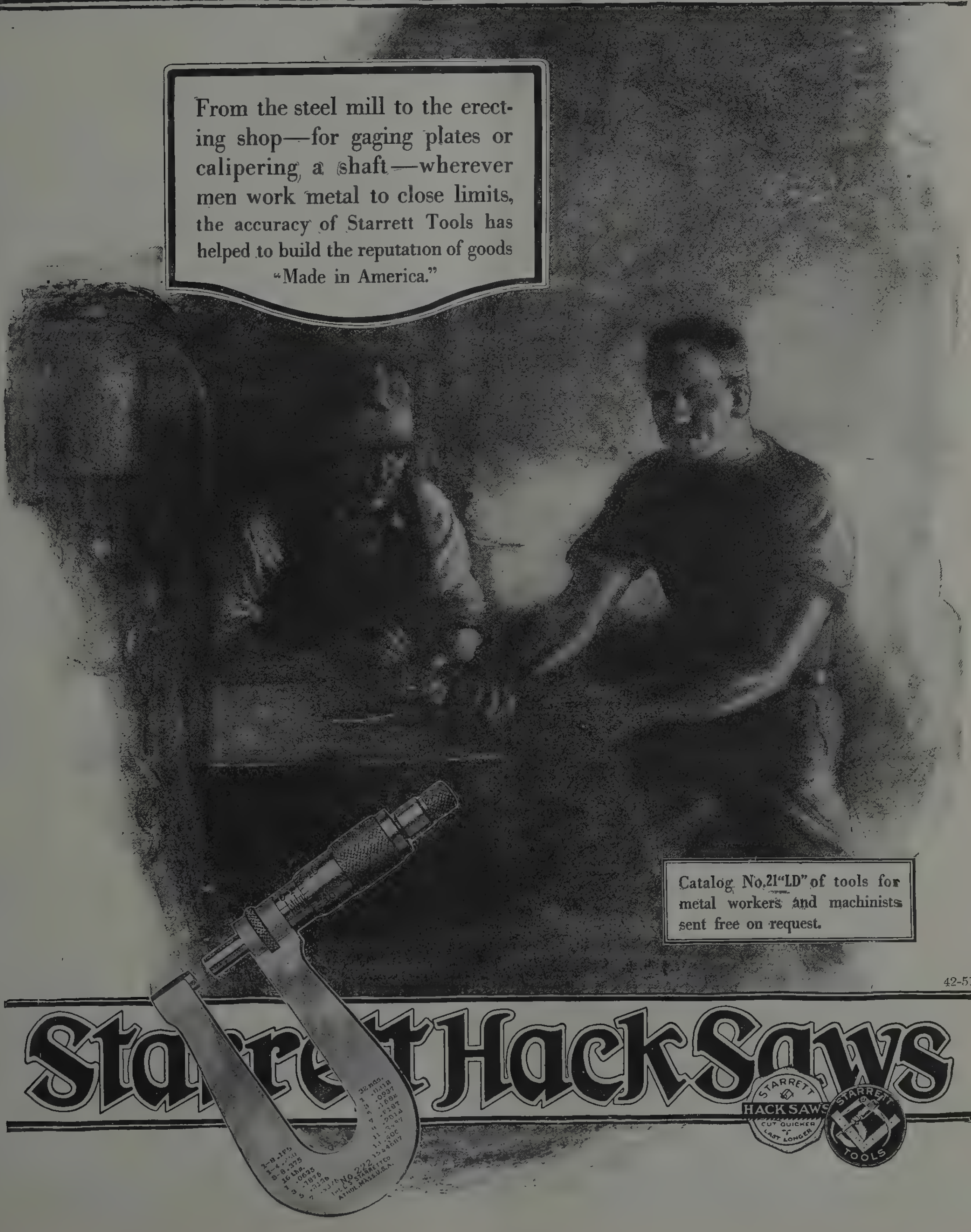

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Starrett Hack Saws

ENGINEERING INDEX (Continued)

COAL TAR

Industrial Technology

Modern Technology of the Coal Tar Industry—XI (La technique moderne de l'industrie des goudrons de houille), M. C. Berthelot. Revue de Métallurgie, vol. 17, no. 4, April 1920, pp. 252-261, 11 figs. Survey of processes for continuous distillation of tar. Processes for the complete transformation of tar into rosin. (Continuation of serial.)

COKE

Quality, Criteria of

Carbon Blisters and Carbon Threads are said to be Evidence of Good Coke. Coal Age, vol. 18, no. 4, July 22, 1920, pp. 173-174, 1 fig. Undecomposed hydrocarbons at bottom of oven rise into fierce glow of upper part of charge, where they split, leaving pure carbon on coke faces.

COKE MANUFACTURE

Foundry Coke

Manufacture of Foundry Coke, Edward H. Bauer. Gas Rec., vol. 18, nos. 1 and 2, July 14 and 28, 1920, pp. 15-21, 12 figs., and 21-24 and 46, 10 figs. Method used by Providence Gas Co. in making high-grade fuel, together with details of coke-oven plant. Effect of various coal mixtures and quenching upon quality of metallurgical coke produced.

COKE PLANTS

By-Product

Condensation in Coke Plants (Sur la condensation dans les cokeries), E. Orè. Technique Moderne, Vol. 12, no. 1, Jan. 1920, pp. 7-11, 21 figs. Comparative value of industrial by-product distillation processes.

Making By-product Foundry Coke in New England, H. R. Simonds. Iron Trade Rev., vol. 66, no. 21, May 20, 1920, pp. 1467-1471, 9 figs. Isolated gas and coke-making plant in Rhode Island devotes attention to cupola fuel. By-product coke used more generally in New England because of restrictions on transportation of beehive oven fuel. Relation of low- and high-volatile coals in coke-making.

COLUMNS

Reinforced-Concrete

Experiments with Spirally Reinforced Concrete Columns With and Without Stone Cores at the Technical High School of Vienna (Versuche mit umschnürten Betonsäulen mit und ohne Steinkernen an der Technischen Hochschule Wien). Beton u. Eisen, vol. 19, nos. 1 and 4-5, Jan. 8 and Mar. 4, 1920, pp. 10-13 and 44-46, 8 figs. Results of tests with two kinds of concrete, showing that with the richer mixture the utilization of core and influence of reinforcing decrease, in spite of which total strength increases.

COMPRESSED AIR

Hydroelectric Plants

San Joaquin Light and Power Corporation's Kerckhoff Power Project, W. C. Collyer. Compressed Air Mag., vol. 25, no. 8, Aug. 1920, pp. 9757-9758, 3 figs. Compressed-air equipment at hydroelectric power development to utilize water of San Joaquin River at Auberry, Cal.

Railway Terminals

St. Paul's New Union Depot Serving Ten Railroads, Francis Judson Tietsort. Compressed Air Mag., vol. 25, no. 8, Aug. 1920, pp. 9759-9761, 7 figs. Uses of compressed air in building structure and for testing air brakes for repair tools and for enginehouse requirements.

CONCRETE

Compressive Strength

Compressive Strength of Concrete in Flexure, W. A. Slater and R. R. Zipprodt. Can. Engr., vol. 39, no. 2, July 8, 1920, pp. 123-127, 8 figs. Description of special tests conducted at Lehigh University and Lafayette College, from which it is concluded that 45 per cent of the compressive strength of the concrete may be used as a working stress.

Curing of

Soaking Concrete in $MgSiF_6$ and $Na_2Si_4O_9$ Solutions. Concrete, vol. 17, no. 1, July 1920, pp. 28-29, 6 figs. Tests indicate that the 1:1:2 concrete cured in $MgSiF_6$ solutions was improved in strength for three out of four different curing conditions.

Electric Resistance of

Concrete in Connection with Electrical Accidents (Beton und elektrischer Unfall), Stefan Jellinek. Beton u. Eisen, vol. 19, nos. 2-3 and 4-5, Feb. 4 and Mar. 4, 1920, pp. 27-29 and 47-49. Results of investigations carried out at different times and places of electrical resistance of concrete and the changes in concrete caused by electricity, based on works by Berndt and his collaborators.

Proportioning

Volume-Moisture Relation in Sand and a Method of Determining Surface Area Based Thereon, R. B. Young, and W. D. Walcott. Eng. and Contracting, vol. 54, no. 4, July 28, 1920, pp. 91-94, 6 figs. It is concluded from tests that surface area must be taken into account in any method of proportioning concrete mixtures.

Strength, Influence of Jarring on

Influence of Jarring on the Strength of Concrete (Der Einfluss von Erschütterungen auf die Festigkeit des Betons), Hans Schäfer. Prometheus, vol. 31, no. 18, Jan. 31, 1920, pp. 140-142. Results of experiments carried out in the Saxon Mech-Technical Experimental Inst., Dresden, are said to show that a slight jarring before setting begins will have a favorable effect on strength of concrete; during setting period its influence varies and precautions should be taken; after cement is hardened no apparent effect is noted.

Watertight

Watertight Concrete. Nat. Lime Assn., bul. no. 301, 1920, 20 pp. 12 figs. Summary of facts concerning effects of hydrated lime in improving structure of reinforced concrete and rendering it impermeable to water, together with comments and field data concerning beneficial effects resulting from its use.

CONCRETE, REINFORCED

Flat Slabs, Design of

New York City Regulations for Design of Reinforced Concrete Flat Slabs. Eng. and Contracting, vol. 54, no. 4, July 28, 1920, pp 89-91. Rules adopted by Board of Standards and Appeals governing design of reinforced-concrete flat slabs.

CONDENSERS, STEAM

Circulating-Water Strainers

The Straining of Circulating Water. Eng., vol. 109, no. 2838, May 21, 1920, p. 679, 4 figs. Patented scheme in which straining surface is outside of perforated drum built up of gun-metal plates on cast-iron spiders, one end of drum being closed and the other open to outlet for strained water.

CONVERTERS

Rotary

Phasing-Out Rotary Converters, K. A. Reed. Power, Vol. 52, no. 2, July 13, 1920, pp. 51-53, 6 figs. Method is outlined which required no other equipment than a number of lamps and special brushes.

CONVEYORS

Apron-Type

Kinlok Mine of the Valley Camp Coal Co., J. W. Marshall. Coal Industry, vol. 3, no. 7, July 1920, pp. 307-310, 3 figs. Description and operation of apron-type conveyor said to be largest now being used in U. S.

Belt, Wooden-Link

The Kaul Wooden Conveyor Belt [Das Holzglieder-Förderband (System Kaul)], Heinz Gante. Fördertechnik u. Frachtverkehr, vol. 13, no. 4, Feb. 20, 1920, pp. 41-42, 1 fig. Describes belt consisting of wooden links, 50x50x20 mm. jointed together horizontally with Mannesmann tubes, which is said to have been used successfully in anthracite, lignite, cement, food-products and chemical industries as well as for coaling plants.

Belt, Wooden-Slat

The Killewald Wooden Conveyor Belt (Das Holzgliedförderband "System Killewald"). Fördertechnik u. Frachtverkehr, vol. 13, no. 5, Mar. 5, 1920, pp. 56-57, 2 figs. Describes conveyor exhibited at the Leipzig Exposition by the Bernburg Potash Works, consisting of two parallel wire ropes to which narrow wooden slats are clamped to form the conveying surface, original feature of which lies in the arrangement and fastening of the bars on the wire ropes.

COPPER ALLOYS

Phosphor-Copper

New Process for Making Fifteen Per Cent Phosphor-Copper, P. E. Demmler. Metal Industry (New York), vol. 18, no. 7, July, 1920, pp. 314-315, 1 fig. Gives particulars of experiments of authors showing that a uniform 15 per cent phosphor-copper can be produced by passing phosphorus vapor over heated copper, and that most satisfactory temperature of copper is 400 deg. cent. Paper to be presented in Oct. before Inst. Metals Division of Am. Inst. Min. & Met. Engrs.

COPPER METALLURGY

Electrolytic Assaying

The Electrolytic Copper Assay—A New Modification, F. G. Hawley. Eng. and Min. Jl., vol. 110, no. 4, July 24, 1920, pp. 162-165. Proposed method claimed to be of special advantage in the presence of impurities such as arsenic, antimony, bismuth, selenium, and molybdenum.

Refining

Elements of Design of a Copper Refinery, Lawrence Addicks. Chem. & Metallurgical Eng., vol. 23, no. 5, Aug. 4, 1920, pp. 193-196, 3 figs. Two general principles are laid down: (1) that all impurities possible should be eliminated at anode furnaces, using basic furnaces if necessary; and (2) that anodes of constant composition, uniform current density and single electrolyte should be used throughout tank house.

COPPER MINING

See TIME STUDY, Application to Mining Operation.

CORROSION

Iron and Steel

Experiments on the Corrosion of Iron and Steel, William D. Richardson. Chem. & Metallurgical Eng., vol. 23, no. 6, Aug. 11, 1920, pp. 243-250, 2 figs. Corrosion losses on 24 different kinds of iron and steel were recorded for test period of 1000 days' immersion in air and brine, quiet and air agitated, with or without periodical drying. From paper read before Inst. of Chem. Engrs.

COST ACCOUNTING

Engineers and Contractors, System for

Accounts of Engineers and Contractors, C. A. H. Narlan. Jl. of Accountancy, vol. 30, no. 2, Aug. 1920, pp. 81-87. Advises following coördinated cost system which will permit comparison of actual unit costs with estimates prepared by engineer. Suggestions are given for recording charges for labor and overhead.

CRANES

Design

The Determination of the Loads on Crane Wheels, E. L. Montagnon. Eng., vol. 109, no. 2839, May 28, 1920, pp. 705-707, 6 figs. Method of taking moment is suggested which is said to give same answer for steel loads whether upper and lower portion of cranes are treated separately or combined at their common center of gravity.

Dock

The New Unloading Installations of Port of Bordeaux (Les nouvelles installations de déchargement du port de Bordeaux), Henry Martin. Génie Civil, vol. 77, no. 1, July 3, 1920, pp. 1-8, 18 figs. partly on supp. plate. Details of travelling cranes. (To be continued.)

CYANIDES

Canada

Canadian Cyanide: Its Manufacture and Utilisation, W. S. Landis. Chem. Age (Lond.), vol. 3, no. 59, July 31, 1920, pp. 127-128. Process involves mixing cyanamide and common salt together and melting mixture in special type of single-phase electric furnace.

D

DAMS

Arched Concrete

The Reinforced Concrete Arch Dam, F. A. Noetzli. Jl. of Elec., vol. 45, no. 2, July 15, 1920, pp. 79-80. Technical details of arch dam of fairly slender cross section recently completed in Sweden.

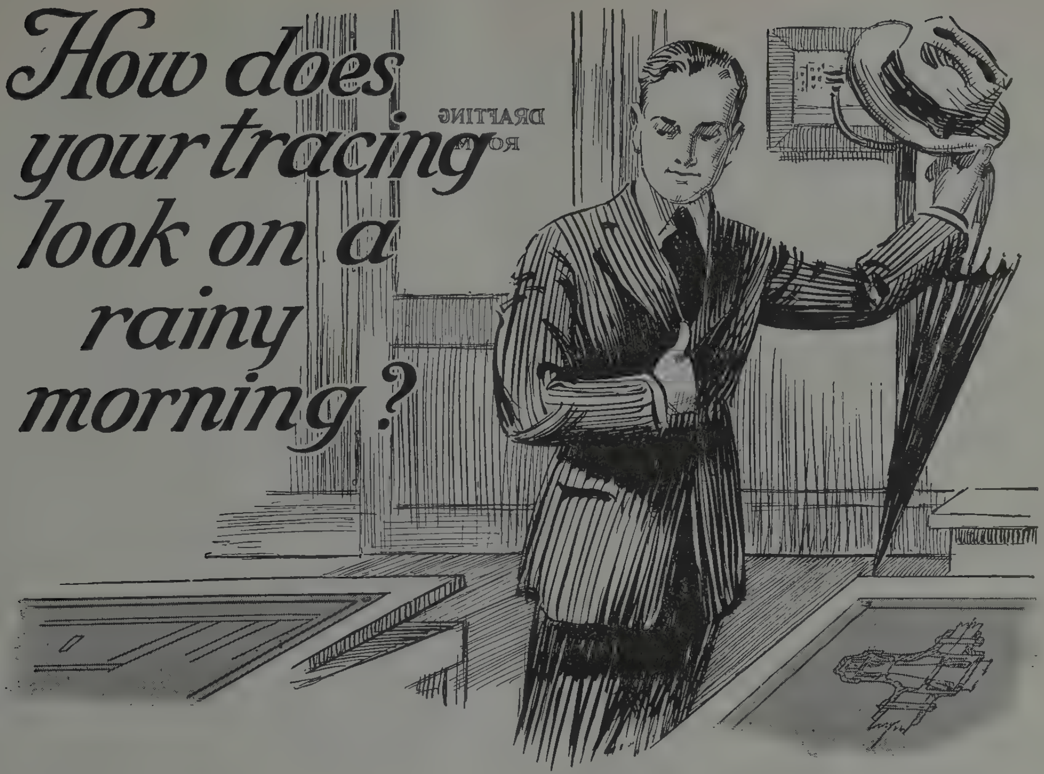
Artificial Lakes

Evolution of Dam Construction for Artificial Lakes (L'évolution des grandes digues pour lacs artificiels), M. Luigi Luiggi. Annales des Ponts et Chassées, vol. 55, no. 2, March-April 1920, pp. 232-268, 19 figs. Comparative study of ancient and modern designs. For heights up to 90 ft. earth embankment with drainage aqueduct of Ambursen type is preferred; from 90 ft. to 180 ft. masonry dams are advised, specially multiple-arch dams for greater heights; for heights from 180 ft. to 300 ft. and in exceptional cases when expense is secondary element, masonry gravity dams are considered the safest. Paper read before Société des Ingénieurs et Architectes italiens.

DIESEL ENGINES

Air-Pressure Regulators

Influencing the Combustion Line of Diesel-Engine Indicator Cards (Die Beeinflussung der Brennlinie bei Dieselmotoren), Ludwig Eber-



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mann. Zeitschrift des Vereines deutscher ingenieure, vol. 64, no. 23-24, June 12, 1920. pp. 425-431, 22 figs. Points out necessity of altering air injection to correspond with variations in load, and suggests most suitable means therefor. Describes "MAN" air-pressure regulator of Benz & Co., Inc., and the Sulzer Bros. regulator.

Busch-Sulzer

The Busch-Sulzer Two-Cycle Diesel Engine. Power, vol. 52, no. 2, July 13, 1920, pp. 46-49, 7 figs. Engine is of vertical four- or six-cylinder single-acting cross-head type.

Experimental Work

Some Experimental Work in Connection with Diesel Engines, C. J. Hawkes. Eng. & Indus. Management, vol. 4, no. 5, July 29, 1920, pp. 141-144, 3 figs. Outline of experimental work carried out at Admiralty Engineering Laboratory in connection with internal-combustion engines for naval purposes, with special reference to design and performance of single-cylinder engine of comparatively large power. (To be continued.) Paper read before Instn. Naval Architects.

Progress in Germany

Progress in Marine Diesel Engine Building at Krupp's during the War—H. Otto Alt. Motorship, vol. 5, no. 8, Aug, 1920, pp. 694-696, 9 figs. Discusses injection type of engine, heat stresses, etc. (To be continued.)

Tests

Some Experimental Work in Connection with Diesel Engines, C. J. Hawkes. Eng., vol. 110, no. 2847, July 23, 1920, pp. 127-131, 8 figs. Outline of experimental work carried out at Admiralty Engineering Laboratory in connection with internal-combustion engines for naval purposes, with special reference to design and performance of single-cylinder engine of comparatively large power. Paper read before Instn. Naval Architects.

Werkspoor

The Werkspoor Engine. Engr., vol. 129, no. 3357, April 30, 1920, pp. 446-448, and p. 450, 9 figs. Progress in design of Diesel engines built at Nederlandsche Fabriek of Amsterdam. One set installed on board Salerno, a ship of 6700 tons deadweight, is described.

Worthington

The Worthington Marine Diesel Oil Engine. Int. Marine Eng., vol. 25, no. 8, Aug. 1920, pp. 672-686, 23 figs. 1 on suppl. plate. Six-cylander, four-cycle reversible marine Diesel engine, capable of developing 2400 i.h.p. at 120 r.p.m.

[See also CENTRAL STATIONS. Oil-burning Engines.]

DIRECTION FINDERS

Reliability of

Radio Direction Changes and Variations of Audibility, Carl Kinsley and Albert Sobey. Proc. Inst. of Radio Engrs., vol. 8, no. 4, Aug. 1920, pp. 299-323, 12 figs. As result of large number of systematic measurements on direction of incoming signals, using loop reception, variations of considerable magnitude in apparent direction and occurring within short periods of time are found. Their dependence on length and character of wave are studied and certain possible theories of transmission are proposed to account for observed phenomena.

DREDGING

Stumpy Ground

Special Impellers for Pumps in Dredging Stumpy Ground, Walter J. White. Eng. News-Rec., vol. 85, no. 4, July 22, 1920, pp. 166-170, 11 figs. Centrifugals on New Orleans industrial canal, it is said, were rebuilt like wood sewage trash pumps and efficiency increased.

DRILLING MACHINES

Radial

New Radial Drill. Iron Age, vol. 106, no. 1, July 1, 1920, pp. 8-10, 5 figs. Machine having double-beam-section column with electric clamp.

Tilting Table for

The "Asquith" Patent Universal Tilting Table. H. Bentley. Eng. Production, vol. 1. no. 7, July, 1920, pp. 247-248, 5 figs. Details of fixture for handling heavy work, consisting of a strong main axle or pivot, which is adjustable through a complete circle, and which has stops for every 90 deg.; it is operated by hand, but can be electrically operated if desired.

DRILLS

Twist

The Use and Abuse of Twist Drills, H. Wills. Iron Age, vol. 106, no. 8, Aug. 19, 1920, pp. 461-463, 12 figs. Examples of incorrect grinding are given and results are pointed out. Grinding rules are formulated.

DROP FORGING

Plants

New Drop Forge Plant at Pittsburgh. Iron Age, vol. 106, no. 5, July 29, 1920, pp. 253-257, 7 figs. Group arrangements of forging sets, furnaces and machine tools, transportation system and employee comfort features, it is said, make for quantity production.

DRYDOCKS

Graving Docks

New Graving Docks at Portsmouth, Va., Harrison S. Taft, Int. Marine Eng., vol. 25, no. 8, Aug. 1920, pp. 647-650, 3 figs. Description of three concrete graving drydocks, built on arch type of construction, at Norfolk Navy Yard.

DURALUMIN

Properties

Light Alloys of Great Strength (Alliages légers à haute résistance), M. Grard. Revue de Métallurgie, vol. 17, no. 4, April 1920, pp. 286-300, 21 figs. Results of test on duralumin. Tests comprised variation of mechanical properties with hardening by hammer and with consecutive heat treatment, and also study of temper in treatment of tempering temperature, and speed of cooling. Abstract of book entitled, "l'Aluminium et ses Alliages," soon to be published by Berger-Levrault.

DYNAMOMETER CARS

Swiss State Railways

Dyamometer Car for Swiss State Railways. Eng., vol. 109, no. 2843, June 25, 1920, pp. 871-874, 13 figs. Car embodies testing laboratory equipped with measuring apparatus and auxiliary recording instruments and devices whereby are met all requirements demanded in different running tests for determining efficiency of locomotives, resistance of trucks or trains of various kinds, and power required for propelling trains on certain lines under different running conditions. Paper read before Ipswich Eng. Soc.

E

ELECTRIC CONTACTS

Calculation

The Calculation of Contacts (Die Berechnung von Kontakten), Wilhelm Höpp. Elektrotechnische Zeitschrift, vol. 41, nos. 11 and 12. Mar. 11 and 18, 1920, pp. 205-208 and 232-235, 23 figs. With aid of oxidation measurements, directions are given for calculation of contacts, and calculation formula is developed under consideration of additional losses through contact resistances and influence of cross-sectional changes. It is shown that contact losses are practically independent of size of contact surface and only total pressure and cleanness of surfaces are of importance.

ELECTRIC CURRENTS, ALTERNATING

Rectification by Galena

Two Ways of Rectification of Currents by Galena (Sur deux modes de rectification des courants par les galènes), Paule Collet. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 25, June 21, 1920, pp. 1489-1491. Writer claims to have observed in experiments, (1) that when a small electric current traverses lead sulphite ore introduced in a metallic circuit, there is a positive flow from ore to metal, and (2) that when current is large there is a negative flow.

ELECTRIC FURNACES

Non-Ferrous Work

Electric Furnaces, J. H. Stansbie. Metal Industry (London) vol. 14, no. 24, June 13, 1919, pp 483-487, 2 figs. Prominence given to use of electric furnaces for non-ferrous work is noted and information presented as to great possibilities of zirconium as refractory for furnace lining. Report of joint meeting of Birmingham Branch of British Foundrymen's Assn. and Birmingham Metallurgical Soc. and Staffordshire Iron & Steel Ist. (To be concluded.)

ELECTRIC GENERATORS, A. C.

Field Excitation

Connected Load Versus Generator Capacity, Fraser Jeffrey. Power, vol. 52, no. 5, Aug. 3, 1920, pp. 162-164fi 5 figs. Limitations to field excitation are discussed, with special reference to starting periods of squirrel-cage induction motors.

[See also TURBO-GENERATORS.]

ELECTRIC LAMPS, INCANDESCENT

Luminous Efficiency

Luminous Efficiency of Incandescent Bodies (Etude du rendement lumineux des corps incandescents), R. Painvin. Revue générale de l'Electricité, vol. 7, no. 24, June 12, 1920, pp. 787-791. Formula is established for calculating, in terms of temperature, luminous efficiency of carbon and tungtsen filaments of incandescent lamps.

ELECTRIC LOCOMOTIVES

Citröen-Geared

Citröen Gear for Electric Locomotives. Eng., vol. 109, no. 2839, May 28, 1920, pp. 712-715, 8 figs. Power transmitted by gearing is 1000 b.hp. on speeds of 550 r.p.m. and 169 r.p.m., corresponding to traveling speed of 26 m.p.h., with wheels 4 ft. 3½ in. in diameter, maximum speed being 920 r.p.m. at motor and 43.5 m.p.h. on track.

Swiss Railways

Swiss Federal Railways Buy New Electric Locomotives. Elec. Ry. Jl., vol. 56, no. 6, Aug. 7, 1920, pp. 256-260, 10 figs. Single-phase freight locomotives manufactured by Oerlikon Co. Data: Height, 12 ft. 5 in.; total length, 63 ft. 6 in.; gage, 4 ft. 8½ in.; diameter, 53¼ in.; crankpin stroke, 23⅝ in.; transmission ratio, 43.03; total weight, 256,000 lb.; adhesive weight, 208,000 lb.

ELECTRIC MOTORS, A.C.

Induction

How to Calculate a New Winding for an Inductor-Motor Stator Core, A. M. Dudley. Power, vol. 52, no. 1, July 6. 1920, pp. 13-18 5 figs. Six factors that require consideration in figuring new winding for induction motor to operate under new conditions of speed, horsepower, voltage, phase or frequency are enumerated, then problem is worked out to show how each is determined.

ELECTRIC PLANTS

Commonwealth Edison Co., Chicago

Service Work for 1919 Below Pre-War Cost, D. W. Roper. Elec. World, vol. 76. no. 6, Aug. 7. 1920. pp. 273-276, 7 figs. Operating records of Commonwealth Edison Co., Chicago. It is said that in spite of increased wages and inroads of war and industry on ranks of trained workers, careful engineering has succeeded in reducing cost. Factors that have played a part in bringing this about are enumerated.

Parallel Operation

Governor Adjustment for Efficient Parallel Operation, F. Oppenheimer. Elec. World, vol. 76, no. 5, July 31, 1920, pp. 239-240, 9 figs. Principles of operating steam and hydroelectric plants in parallel and methods of changing governor regulations while running.

ELECTRIC RAILWAYS

Supplying Parts to Repair Shops

Supplying Repair Parts to Shops, W. G. Murrin. Elec. Ry. Jl., vol. 56, no. 2, July 10, 1920, pp. 85-86, 1 fig. Canadian company replaces worn-out supply car with auto truck; sends salvage car monthly over interurban division. Advantage of plan is that it enables foreman in each repair shop to accumulate pieces for repair until a man or machine can do the work in quantities and so reduce unit cost.

ELECTRIC RAILWAY SIGNALS

Dual Control

Dual Control Signals on the Pacific Electric, Clifford A. Elliott. Elec. Ry. Jl., vol. 56, no. 7, Aug. 14, 1920, pp. 321-322, 4 figs. Improved type of signal-light circuit adopted for single-track line to minimize hazardous operating conditions.

ELECTRIC RAILWAYS, TRACK

Current Losses

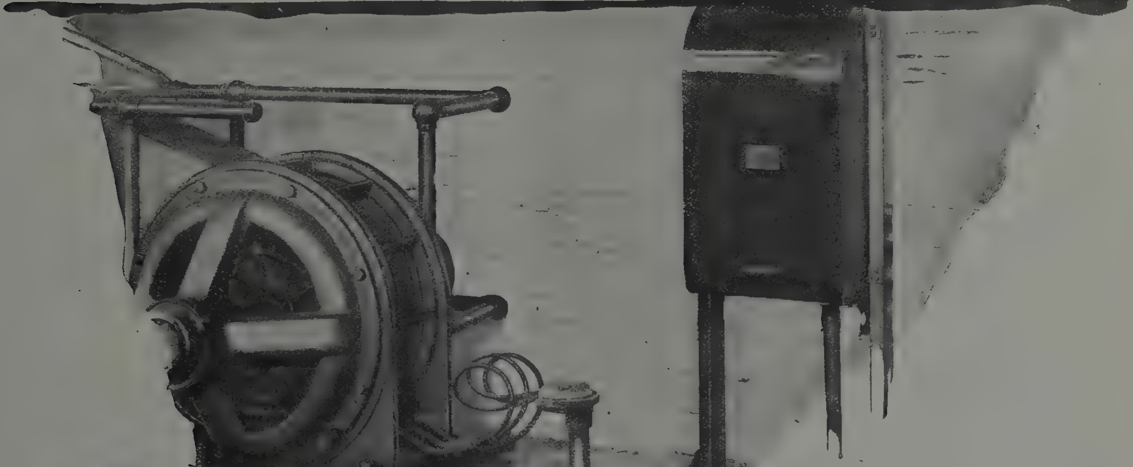
Current Losses in Electric Railway Tracks (Sur les pertes de courant qui se produisent le long des voies de tramways), G Girousse. Revue générale de l'Electricité, vol. 8, no. 1, July 3. 1920. pp. 837-844. 10 figs. Simplifications of usual formulæ are suggested.

ELECTRIC TRANSMISSION LINES

Construction Costs

Interconnecting Small Cities. Elec. World, vol. 76, no. 7. Aug. 14, 1920, pp. 321-324, 7 figs. Data on costs of present-day line construction, together with methods of emer-

Safety to operators, machinery and motors—safety that insures consistently high production can be supplied by properly applied electric control equipment



Easy to install—the case is hung from a detachable conduit box which is installed first and used as a pull box. Conduit may be run directly to this box from above, below, or either side.

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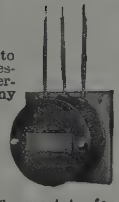

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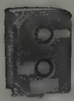
Float Switch — for control of liquid levels.



Push Button Station—the finger tip device for magnetic control.

Safety First—with CR 7052 Automatic Compensators

In CR 7052 automatic starting compensators, standardized features are combined to safely control squirrel cage induction motors.

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Complete details showing how these compensators meet every requirement for starting squirrel cage induction motors, when operated by push button or master switch, will be supplied by our nearest office.

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ENGINEERING INDEX (Continued)

gency operation, collected from Indiana central-station companies serving 21 communities.

Feeder Voltage Regulation

Calculation of Feeder Voltage Regulation, W. C. Chappell. Elec. World, vol. 76, no 2, July 10, 1920, pp. 73-74, 1 fig. Chart for computing voltage regulation of given feeder for any load and power factor.

Protection

Protection of Transmission Systems—I, Emil Alm. Elec. World, vol. 76, no. 6, Aug. 7, 1920, pp. 277-278, 2 figs. Analysis of abnormal voltages on transmission systems and methods adopted by company in Sweden to protect station apparatus from insulation breakdown.

ELECTRIC UNITS

Data on

Electric Units and Standards. Circular of Bur. of Standards, no. 60, Mar. 12, 1920, 68 pp. Notes on systems of units, including units in general, electrostatic and electromagnetic systems, and international electric units; evolution of present system of concrete standards; units and standards of principal electric quantities—resistance, current, electromotive force, quantity of electricity, capacity, inductance, power and energy, and resistivity; magnetic units. Appendices on conversion factors, legislation on electric units giving laws of various countries, and bibliography.

ELECTRIC WELDING, ARC

Machines

Automatic Electric Arc Welding Machine, H. L. Unland. Welding Engr., vol. 5, no. 7. July 1920, pp. 26-28, and 32, 14 figs. Automatic arc welder is a device for automatically feeding metallic electrode wire into welding arc at rate required to hold a constant arc length. Article describes investigation to determine controlling feed of electrode to electric arc in a metallic-electrode welding circuit.

Electric Welding Machines — Direct-Current Constant-Potential Types, L. W. Webb. Power, vol. 52, no. 6, Aug. 10, 1920, pp. 210-212, 4 figs. Operation of different makes of welding machines of constant-potential type.

Metal Deposition in

Metal Deposition in Arc Welding—II, O. H. Escholz. Elec. World, vol. 76, no 3, July 17, 1920, pp. 118-121, 11 figs. Mechanism of metal transfer from electrode to plate is explained by the aid of photography. Evidence indicates that 85 per cent of the metal is carried across arc in liquid form by molecular forces.

ELECTRICAL MATERIAL

Standardization, France

French Rules of Standardization of Electrical Material (Règles françaises d'unification du matérial électrique). Jl. des Usines à Gaz, vol. 44, no. 9, May 5, 1920, pp. 129-135, 4 figs. Prepared by French Electrotechnical Committee. Regulations refer to insulators, armored cables, etc.

ELECTRICITY

Atmospheric, Utilization of

A New Source of Energy and Its Useful Possibilities (Eine neue Energiequelle und deren Verwendungsmöglichkeiten für die chemische Industrie), Hermann Plauson. Chemiker-Zeitung, vol. 44, no. 34-35, Mar. 23, 1920. pp. 229-231. Notes on recovery and utilization of atmospheric electricity, which, it is claimed can be utilized in a practical manner and which offers the prospect of a working capacity of 200 hp. in form of electric energy for every sq. km. of soil. Some of its uses in chemical and electrochmical industries are pointed out.

Price Per Kw-Hr.

Alignment Charts for the Graphical Computation of Rates of Electricity (Abaques à alignement pour le calcul graphique des tarifs d'électricité), R. Courau. Revue générale de l'Electricité, vol. 7, no. 24, June 12, 1920, pp. 801-807, 4 figs. Graphs constructed from formulæ for determing price of kw-hr.

ELECTROLYSIS

Electric Waves, Influence of

The influence of Electric Waves on Electrolysis (Einfluss elektrischer Wellen auf die Elektrolyse), Franz Grünwald. Elektrotechnischer Anzeiger, vol. 37, no. 36, Mar. 3, 1920. p. 170, 1 fig. It is stated that North German Refinery uses for gold refining, direct current with superimposed unsymmetrical alternating current of 50 periods per sec., according to Wohlwill process.

ELECTROMAGNETISM

Galvanomagnetic Effects

Analysis of Three Galvanomagnetic Effects. Confirmation of a New Effect (Analyse de trois effets galvanomagnétiques. Confirmation d'un nouvel effet), A. Sellerio. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 26, Jun 28, 1920, pp. 1570-1573, 2 figs. Experimental study claimed to have confirmed that when a plate is traversed by an electric current perpendicular to a magnetic field, the field causes flow of current along lines of magnetic force.

ELEVATORS

Worm Gears

Electric-Elevator Machinery. Worm Gears and Their Lubrication, M. A. Meyers. Power, vol. 52. no. 4, July 27, 1920, pp. 136-138, 6 figs. How to remove worm gear from elevator reduction gear is explained. Castor oil is recommended as best for lubrication.

EMPLOYEES' REPRESENTATION

Advantages

Letting Your Employees do the Hiring. Factory, vol. 25, no. 1, July 1, 1920, pp. 41-44, 1 fig. Method of employee representation lowers labor turnover, assures adequate supply of labor and builds up in the minds of the workers feeling that they are part of the institution, writer believes.

Whitley Councils

The Operation of the Whitley Councils—I. Metal Industry (N. Y.), vol. 18, no. 8, Aug. 1920, pp. 367-368. History, development and present state of England's experiment in coöperation between employer and employee.

EMPLOYEES, TRAINING OF

Moving Pictures

How Movies can Help You Train Workers, Alfred Pittman. Factory, vol. 25, no. 1, July 1, 1920, pp. 29-32, 5 figs. How a number of concerns have used the movies to recruit and train employees. Suggested uses.

EMPLOYMENT MANAGEMENT

Charts

Practical Personal Management, Earl B. Morgan. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 122-129, 16 figs. Forms and charts used at employment and service department, Curtis Publishing Co.

Psychological Qualifications

Practical Results from Industrial Psychotechnology (Praktische Ergebnisse aus der industriellen Psychotechnik). H. Schlesinger. Zeitschrift des Vereines deutcher Ingenieure, vol. 64, no. 23-24, June 12, 1920, pp. 417-424, 17 figs. It is shown that psychological qualification investigations are a practical means of finding the right man for the right occupation. Notes on apparatus used to test sight and touch; examination of attentive and imaginative faculty; of constructive talent and technical understanding. Comparison between results from laboratory and workshop, and data on special cases, such as chauffeurs, telephone workers, etc.

Testing Employees

Investigation of Vocational Qualifications (Untersuchungen über Berufseignung), H. Schlesinger. Deutsche optische Wochenschrift, nos. 5-6, Feb. 2, 1920, pp. 39-43, 12 figs. Description of apparatus and methods of testing physical qualifications of employees.

Vocational Tests, Cyril Burt. Eng. & Indus. Management, vol. 4, no. 6, Aug. 5, 1920, pp. 166-169. Importance of "putting the right man in the right job." (To be continued.) Lecture delivered at Psychological Laboratory, Cambridge University.

ENGINEERING SOCIETIES

Technical Publications

Co-Ordination of Technical and Scientific Publications. Eng., vol. 110, no. 2846, July 16, 1920, p. 80. Suggests in order to meet "difficulty of keeping track of all that is written on a given subject," so much increased of late because "multiplication of societies and the great activity of all departments of science and engineering have given rise to an ever-increasing volume of publications containing information, often of interest and sometimes of great value, to those engaged in occupations on which they have a bearing," that every institution and society publish a fairly full abstract of their papers printed in its ordinary proceedings, such abstracts to be uniform for all institutions in regard to size of page and width of margins.

ENGINEERS

Definitions of

A Study of Definitions of "Professional Engineer" and "Engineering," Alfred D. Flynn, W. Kiddle and Harrison W. Craver, Jl. Eng. Inst. of Canada, vol. 3, no. 8, Aug. 1920, pp. 387-392. Results of labors of Engineering Council's Committee on Licensing of Engineers while framing model bill for registration of engineers.

ENGRAVING MACHINES

Universal

An Engraving and Profiling Machine. Engr., vol. 129, no. 3364, June 18, 1920, pp. 630-631, 4 figs. Machine is said to be capable of forming characters varying in height from 2 in. to 1-32 inch and to be able to engrave either "plain sunk" or in relief.

EVAPORATORS

Design

Studies in Evaporator Design—I, W. L. Badger and P. W. Shepard. Chem. & Metallurgical Eng., vol. 23, no. 6, Aug. 11, 1920, pp. 237-241, 2 figs. Effect of temperature drop and temperature level on heat transmission in vertical-tube evaporators. Corrections for hydrostatic head. Boiling points, heat drops and steam temperatures as factors.

Experiment Station

The Evaporator Experiment Station at the University of Michigan, W. L. Badger and P. W. Shepard, Chem. and Metallurgical Eng., vol. 23, no. 4, July 28, 1920, pp. 159-164, 8 figs. Account of institution of the evaporator laboratory, description of vertical, horizontal and semi-film evaporators and miscellaneous equipment, and program of investigations proposed.

EXCAVATING MACHINES

Dragline

Deep Pit Rock Excavation by Dragline Machines. Eng., News-Rec., vol. 85, no. 5, July 29, 1920, pp. 196-199, 5 figs. Operating ranges of 175 ft. horizontally and 100 ft. vertically are said to have been found practicable in rock cuts for Miami Valley flood-retarding dams.

EXCAVATION, EARTH

Recent Practice

Recent Excavator Practice, F. H. Livens and W. Barnes. Eng., vol. 110, no. 2847, July 23, 1920, pp. 110-114, 15 figs. Progress with steam shovel, commonly known as steam navvy. Various machines introduced within last 8 or 10 years are illustrated and described. Paper read before Instn. Mech. Engrs.

EXPORT TRADE

U. S., Position in

Are We Competitive? L. W. Alwyn-Schmidt. Boiler Maker, vol. 20, no. 8, Aug. 1920, pp. 228-230. Position United States holds as competitor in European nations in world's trade.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FARM MACHINERY

Darlington Show

The Royal Agricultural Show at Darlington. Eng., vol. 110, nos. 2844, 2845 and 2846, July 2, 9 and 16, 1920, pp. 10-12, 42-46 and 71-73, 39 figs. Plows and tractors exhibited. Description of Blackstone cold-starting oil engine, and of Ricardo engine for agricultural tractor. Machine for making concrete building blocks, and portable power hoists.

Engines for Driving

Engines for Thrashing Machines and for Farm Power (Maschinen zum Dreschbetrieb und Kraftmaschinen), J. Charbonnier. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 21-22, May 29, 1920, pp. 399-402, 15 figs. Details of locomobiles, crude oil engines, motor for cranking oil engines, etc., of the "Sparhof" Corp., Würzburg. (Concluded.)

Manufacture

The Lincoln Works of Messrs. Ruston and Hornsby, Limited. Eng., vol. 110, no. 2845, July 9, 1920, pp. 33-37, 15 figs. partly on 4 supp. plates. Threshing machines, clover hullers, elevators, chaff cutters, rice threshers and other kinds of machinery for dressing seed and grain are manufactured, and in addition agricultural gasoline tractor and bodies for Ruston Hornsby motor car. (Concluded.)

The Works of Messrs. Robey and Co., Limited, at Lincoln. Eng., vol. 110, no. 2846, July 16, 1920, pp. 65-71, 27 figs. partly on 4 supp. plates. Farm and mining machinery is manufactured at works. (To be continued.)

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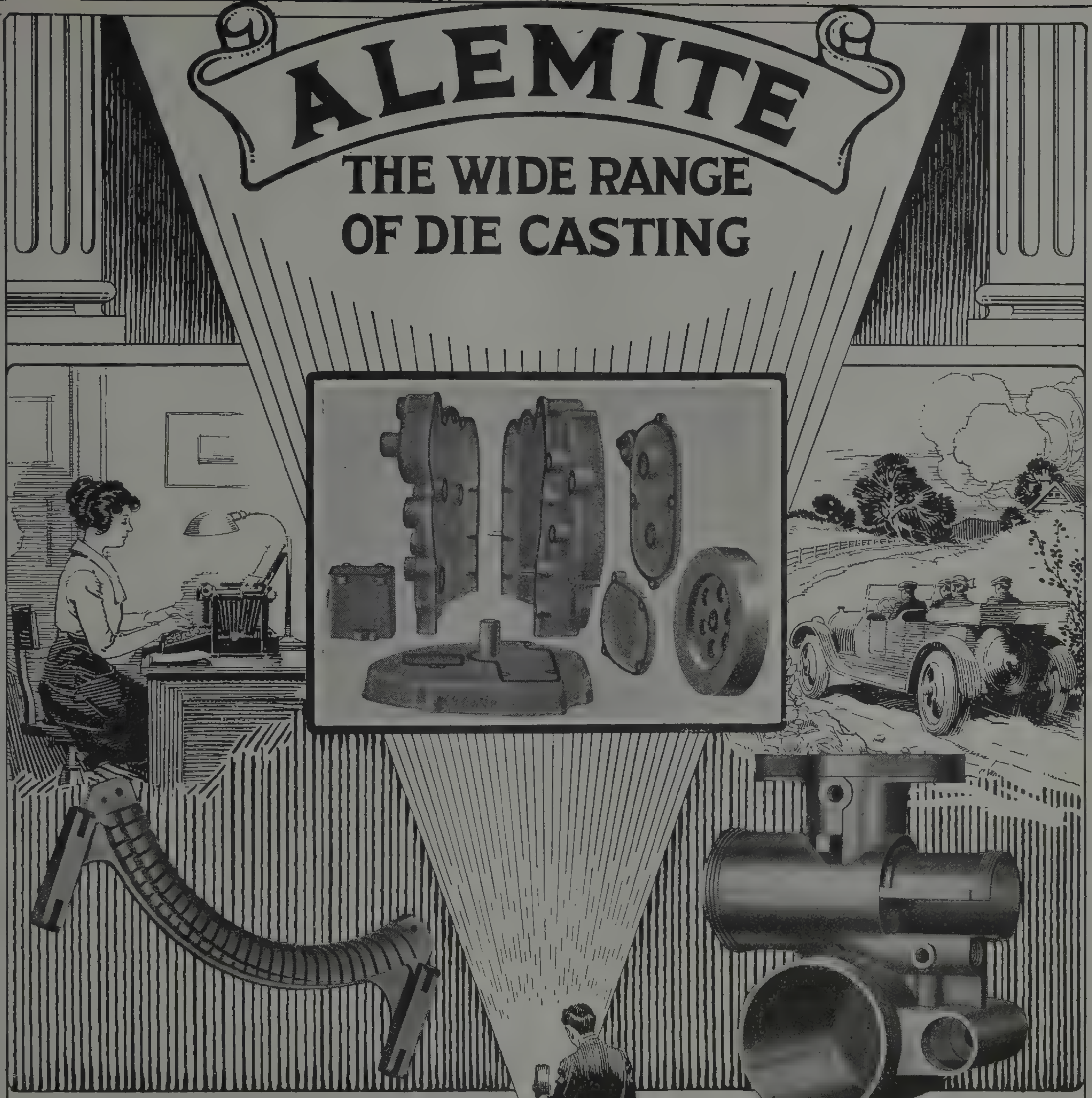

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ENGINEERING INDEX (Continued)

FILTERS

Baffles for

Notes on the Results of Experimental Baffles at Montebello Filters, James W. Armstrong. Jl. of Am. Water Works Assn., vol. 7, no. 4, July 1920, pp. 456-460, 2 figs. Comparison of efficiency of two different basins.

Continuous

Continuous Filtering Drums (Les tambours filtrants continus), Léonce Fabre. Génie Civil, vol. 76, no. 24, June 12, 1920, pp. 525-528, 10 figs. Description of Zenith filter.

FILTERS, SAND

Surface Shrinkage

The Surface Shrinkage of Rapid Filter Sand Beds, Abel Wolman and Sheppard T. Powell. Eng. News-Rec., vol. 85, no. 5, July 29, 1920, pp. 210-216 3 figs. Discussion of causes and importance of varying degree of adsorptive power of sand grains. Application of colloid chemistry concepts to sanitary engineering problem.

FILTRATION PLANTS

England

Rapid Filtration Plant at Birmingham. Eng., vol. 129, no. 3364, June 18, 1920, pp. 622-624, 6 figs. Plant purifies per day 3,000,000 gal. of water pumped from river Blyth as emergency supply.

FIRE PROTECTION

Maintenance of Systems

Care and Maintenance of Fire-Protection Systems—I, C. H. Jenkins. Power, vol. 52, nos. 4 and 5, July 27 and Aug. 10, 1920, pp. 124-127, 1 fig., and 213-216, 4 figs. Suggestions in regard to testing new system and conducting weekly inspections of sprinkler systems.

FIREBRICK

Mortar for

Analyzing Mortar for Firebrick, Raymond M. Howe. Foundry, vol. 48, no. 352, Aug. 1, 1920, pp. 593-595, 6 figs. It is stated that adding foreign materials to mortar used in laying firebrick frequently reduces refractoriness of lining. Tests showed ground brick and clay make effective mixture.

FLIGHT

Analysis

Flight-Course Analysis with the Aid of Photogrammetry (Flugbahnanalyse mit Hilfe der Photogrammetrie), Richard Katzmayr. Motorwagen, vol. 23, nos. 3 and 5, Jan. 31 and Feb. 20, 1920, pp. 46-53 and 91-96, 18 figs. Results of experiments begun in 1914 and continued in 1918. Brief discussion of photogrammetric method of measuring and its use in aeromechanics. Describes two methods for bringing time in definite relation to course traveled. Details of instruments used and of photograms taken.

Wave Soaring

Wave Soaring, W. T. Thomas. Aerial Age, vol. 11, no. 18, July 12, 1920, pp. 616-617, 7 figs. Information on a form of soaring flight employed by brown pelicans on east coast of Florida. It is concluded from analysis of conditions that a well-built aeroplane could exactly reproduce this form of flight, provided that waves of proportionate size existed.

[See also AERONAUTICAL INSTRUMENTS, Flight Indicators.]

FLOW OF FLUIDS

Vortices

On the Stability of Two Rectilinear Vortices of Compressible Fluid Moving in an Incompressible Liquid, Bibhutibhusan Datta. Lond., Edinburgh, and Dublin Philosophical Mag. & Jl. of Sci., vol. 40, no. 235, July, 1920, pp. 138-148. Consideration of the following particular cases: Two columns of fluids of varying density possessing no vorticity; two rectilinear vortices in an incompressible fluid; a vortex pair; and a single vortex parallel to an infinite wall.

FLOW OF WATER

Drainage Ditches

The Flow of Water in Dredged Drainage Ditches, C. E. Ramser. U. S. Dept. of Agriculture, bul. no. 832, June 7, 1920, 60 pp. 52 figs. Results of experiments to determine roughness co-efficient, *n*, in Kutter's formula.

FLYING BOATS

Dornier

The Dornier Giant Flying Boats, Eric Hildesheim. Aviation, vol. 8, no. 11, July 1, 1920, pp. 432-434, 6 figs. Details and illustrations recently released for publication by U. S. Army Air Service, showing various types of Dornier flying boats built by the Zeppelin works.

FOREMEN

Training of

The Foreman and His Development, Charles W. Clark. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 105-109. Course of training for foremen suggested.

FORGING

Progress Since 1912

Progress in Forging Practice During Recent Years (Ueber die Fortschritte auf dem Gebiet der Eisenhüttenkunde in den letzten Jahren), K. Dornhecker. Zeitschrift für angewandte Chemie, vol. 33, nos. 32 and 36, Apr. 20 and May 4, 1920, pp. 96-100 and 106-111, 10 figs. Description of the most important foreign and domestic processes and inventions since 1912.

FOUNDATIONS

Underpinning Methods

Underpinning and Foundations of Heavy Buildings—I. Engr., vol. 129, no. 3365, June 25, 1920, pp. 639-642, 12 figs. Methods of underpinning walls used at various New York and Chicago buildings.

Uniform Pressure on Beds

Uniform Pressure on Building Foundation Beds, R. Fleming. Eng. News-Rec., vol. 85, no. 5, July 29, 1920, pp. 219-223. Review of practice and code provisions, with numerical comparisons for typical office buildings, followed by recommended specification.

FOUNDRIES

Continuous

Continuous Shop is Highly Efficient, Pat Dwyer. Foundry, vol. 48, no. 16, Aug. 15, 1920, pp. 625-630, 9 figs. Among advantages claimed to be derived from continuous foundries are increased tonnage from given floor space and limited flask equipment. Operation of continuous foundry of Air Brake Company, Wilmerding, Pa., for last 30 years is quoted as example.

Design

Toledo Company Building New Plant. Iron Age, vol. 106, no. 8, Aug. 19, 1920, pp. 439-442, 6 figs. Particulars of design of foundry intended for castings ranging in weight from a few ounces to 50 tons.

Increasing Output

Innovations Increase Unit Output—I. Foundry, vol. 48, no. 352, Aug. 1, 1920, pp. 599-607, 11 figs. General features of Saginaw Malleable Iron Co. discussed, and some examples of molding and coremaking procedure presented. (To be continued.)

FOUNDRY EQUIPMENT

Flasks, Steel

Fabricating Steel Foundry Flasks, J. D. Knox. Foundry, vol. 48, no. 16, Aug 15, 1920, pp. 631-634, 15 figs. Rigidity is obtained by forming ribs on 3-inch centers. Bottom half of each rib is made shallow to provide shoulder upon which sand rests. Diversified uses of flasks.

FUELS

Coal, Oil and Sawmill Refuse

Sawmill Refuse, Powdered Coal, and Oil Fuels, Darrah Corbet. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 8, August 1920, pp. 715-732, 2 figs. It is said that "it will be necessary to curtail some of the further development in the use of oil fuel." Advantages of burning pulverized coal and possibilities of using sawmill refuse, are pointed out.

Heating Value

Heating Value of Fuels (Sur la valeur d'usage des combustibles), Emilio Damour. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 26, June 28, 1920, pp. 1578-1581. Heating value is expressed as reciprocal of weights of two fuels which could produce the same thermal effect in a given furnace. A method is outlined for comparing effectiveness of various fuels in any case by means of that definition for heating value.

[See also OIL FUEL; PULVERIZED COAL.]

FURNACES, ANNEALING

Chantraine

The Chantraine Rotary Flame Pot Annealing Furnace. Eng., vol. 109, no. 2840, June 4, 1920, p. 754, 4 figs. Type of furnace which has been largely taken up in Belgium and is being introduced in several plants in England.

FURNACES, BOILER

Air-Cooled Scraper Grate

Experiments with an Air-Cooled Scraper Grate (Versuche mit einem luftkekühlten Staurost), H. Kreyssig. Feuerungstechnik, vol. 8, no. 8, Jan. 15, 1920, pp. 69-71, 3 figs. Gives results of experiments with device installed at the discharge end of the Week traveling grates under the Stirling boilers of the Municipal Elec. Works of Reichenbach, showing its value when lignite briquets are employed as fuel.

Low-Grade Fuels

Boiler Furnaces for Economical Utilization of Low-Grade Fuels (Feuerungsanlagen für Wärmesparwirtschaft bei Verwendung minderwertiger Brennstoffe). Der praktische Maschinen-Konstrukteur, vol. 53, no. 11, Mar. 18, 1920, pp. 83-90, 13 figs. Details of undergraduate blower arrangement for furnace with automatically stoked internally fired boiler, constructed by Germania Machine Factory, Chemnitz; the Topf self-feeding furnace for burning lignite; and traveling grates developed by the firm of C. H. Weck & Co., Dölau for use of low-grade fuels.

FURNACES, HEATING

Revergen

The "Revergen" Forging Furnace. Eng. Production, vol. 1, no. 7, July, 1920, p. 262, 2 figs. Describes improved regenerative system of gas firing, developed by The Davis Fuel Co., London, Eng., with which, it is claimed, considerable fuel economies are effected. Consists of an outer casing of sheeet steel, bound by channels, tie rods, and thrust plates, body of furnace being composed of Scotch firebrick of extra thickness.

G

GAGES

Thread

The Hardening of Screw-Gages with the Least Distortion in Pitch, Wilfrid J. Lineham. Instn. of Mech. Engrs., Jl., no. 5, June 1920, pp. 451-478 and (discussion) 478-529, 40 figs. Paper in two parts, one devoted to water hardening and the other to oil hardening. Object of paper is to prove that quenching, while crossing an arrest or recalescence point, produces the least amount of distortion, and to give the results of the writer's tests. It is also shown that hardening screw gages in oil, after casing in cyanide, can be performed with less distortion than if water is the quenching medium.

Tool-Setting

Precision Type of Planer Tool Setting Gage, Gustave Youngquist. Machy. (N. Y.), vol. 26, no. 12, Aug. 1920, pp. 1121-1122, 4 figs. Tool-setting gage provided with vernier for obtaining direct readings and with means for securing quick and accurate adjustments.

Whitworth Thread

Making Whitworth Thread Gages, C. Edgar Allen. Machy. (N. Y.) vol. 26, no. 12, Aug. 1920, pp. 1157-1160, 5 figs. Method which utilizes disintegration of grinding wheel during grinding operation to produce final thread form.

[See also INTERCHANGEABLE MANUFACTURE, Gages for.]

GAS ENGINES

Körting

Determination of the Degree of Irregularity of a Single-Cylinder Körting Gas Engine and Construction of Curve of Angular Deviations (Ermittlung des Ungleichförmigkietsgrades eines einzylindrigen Körtingsten Gasmotors und Aufzeichnung der Kurve der Winkelabweichungen), O. Bauer. Der praktische Maschinen-Konstrukteur, vol. 53, no. 9, Mar. 4, 1920, pp. 66-72, 4 figs. Gives graphical method and results of investigations which are believed should be of influence in the constructive development of the gas engine.

GAS MAINS

Corrosion

Internal Corrosion of Mains, Services and Meters, J. G. Taplay. Gas World, vol. 72, no. 1872, June 5, 1920, pp. 481-485. Report of Life of Gas Meters Joint Committee of Instn. of Gas Engrs. Findings based on examination of 26 corrosion deposits and liquors contributed by engineers from different parts of England. Preliminary conclusions are given having reference to destructive influence of hydrocyanic acid, salts produced by interaction of ammonia and carbon bi-sulphide, oxygen and carbon dioxide.

GAS MANUFACTURE

Economies of Production

Tests on Carbonization at Uddingston. Gas World, vol. 72, no. 1872, June 5, 1920, pp.

INSURANCE AGAINST COAL SHORTAGE

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492-504, 2 figs. Report of Research Committee of Instn. of Gas Engrs., giving account of first stage of investigation into comparative economies of production, from thermal and chemical standpoints, of different grades of gas. Appendices give in detail method of calibration and analyses employed in research.

Horizontal Retort Installations

Carbonization. Gas World, vol. 72, no. 1872, June 5, 1920, pp. 505-510. Descriptions of various English horizontal carbonization plants illustrating efforts which have been made to satisfy present-day requirements. Paper presented before Instn. of Gas Engrs.

Retort Discharger

The Besnard Retort Discharger. Gas Jl., vol. 151, no. 2986, Aug. 4, 1920, p. 240, 4 figs. Patented apparatus consisting of rake so mounted on end of a horizontal iron tube that it can be extended in horizontal position or brought down at right angles by its own weight and by operation of carrier tube.

GAS PRODUCERS

Marine

Producer Gas for Marine Power. Gas & Oil Power, vol. 15, no. 179, Aug. 5, 1920, pp. 175-178, 3 figs. Report of trials of gas producers patented by D. J. Smith. Consumption trials were carried out on gasoline at various speeds and then at the same speeds on producer gas. Consumption of gasoline and coal for same work was relatively equal.

GAS TURBINES

Holzwarth

The Holzwarth Gas Turbine. Gas & Oil Power, vol. 15, no. 177, June 3, 1920, pp. 145-147, 5 figs. Account of progress made in Germany since 1914 in development of Holzwarth type of gas turbine, extracted from article in Jl. Assn. German Engrs. (Zeitschrift des Vereines deutscher Ingenieure, Feb. 28, 1920).

GAS WORKS

Sulphate Making

The "Direct" Process of Sulphate making in Gas-Works. Gas Jl., vol. 151, no. 2986, Aug. 4, 1920, pp. 234-237. Tables giving comparative cost figures of materials and labor of manufacture of sulphate by ordinary distillation and "direct" processes.

GEAR CUTTING

Gear Shaper

Machining the Gear-Shaper Saddle, Douglas T. Hamilton. Am. Mach., vol. 53, no. 7, Aug. 12, 1920, pp. 293-295, 18 figs. Practice of Fellows Gear Shaper Co., Springfield, Vt.

GEARS

Automobile

Automobile Gear Making Centralized. Iron Age, vol. 106, no. 5, July 29, 1920, pp. 245-250, 10 figs. New works of General Motors Corporation. Well-lighted, single-room machine shop half acre in size and complete heat-treating plant with efficient routing of work.

Design

Gear Teeth Sizes from the Standpoint of Durability—I, Joseph Jandasek. Automotive Industries, vol. 42, no. 24, June 10, 1920, pp. 1305-1308, 4 figs. It is pointed out that all formulæ in current use for calculating gear teeth are based on breaking strength of teeth; but author makes the point that in case of gears for trucks, and especially for farm tractors, calculations should be based on resistance to wear of teeth.

Involute

The Involute Gear—II, Francis W. Shaw. Machy. (Lond.), vol. 16, no. 407, July 15, 1920, pp. 450-453, 5 figs. Relation of tooth form to line of action and effect of varying cutting depth and center distances.

Spur, Patterns for

How Spur Gear Patterns are Made—I, Joseph Horner. Foundry, vol. 48, no. 16, Aug. 15, 1920, pp. 645-648, 13 figs. Methods for laying out material and afterward joining it together to facilitate molding and prevent distortion of patterns while they are in use.

Quantity Production

Making Gears on Quantity Basis, John D. Knox. Iron Trade Rev., vol. 66, no. 24, June 10, 1920, pp. 1679-1682 and 1684, 7 figs. New plant of Dittmer Gear & Mfg. Corp., which was built under adverse conditions, now is producing 2400 gears daily. How obstacles in plant construction were overcome.

[See also MACHINE TOOLS, Herring-Bone Gears for.]

GIRDERS

Plate, Rivet Pitch in

Finding Rivet Pitch in Plate Girders Quickly, Ralph Smillie. Eng. News-Rec., vol. 85, no. 4, July 22, 1920, p. 157, 1 fig. Rivet-pitch diagram for plate-girder flanges, with two lines of ⅞-in. rivets. Bearing value of 24,000 lb. per sq. in. is assumed.

Reinforced-Concrete

The Design of a Long-Span Reinforced Concrete Girder, A. E. Wynn. Eng., vol. 109, no. 2841, June 11, 1920, pp. 777-778, 13 figs. Suggestions for effecting economical design.

GLASS, OPTICAL

Technology of

The Development of Various Types of Glass, G. J. Peddle. Jl. Soc. Glass Technology, vol. 4, no. 13, May, 1920, pp. 3-107, 11 figs. Technology of glass manufacture, divided into five parts: (1) Interaction of silica with oxides of sodium and potassium; (2) interaction of silica with silica, lime, and sodium oxide; (3) interaction of silica, lime, and potassium oxide; (4) interaction of silica, lime, and oxides of sodium and potassium; and (5) comparison of soda-lime-silica and potash-lime-silica glasses.

GLASS MANUFACTURE

Lime, Effect of

The Choice of Glass Batches Containing Lime. W. E. S. Turner. Jl. Am. Ceramic Soc., vol. 3, no. 5, May, 1920, pp. 379-383. Results of tests are recorded in tabular form, in which effect of several reagents is measured by loss in weight suffered by each 100 sq. cm. of surface. It is noted that water is most corrosive liquid when either no lime or very little is present, while strong caustic alkali has least effect; also that as amount of lime is increased, corrosive action very rapidly falls off. From Department of Glass Technology, University of Sheffield, Eng.

GLUES

Properties

Properties and Constitution of Glues and Gelatines. Robert H. Bogue. Chem. & Met. Eng., vol. 23, nos. 1, 2, 3, 4 and 5, July 7, 17, 21, 28, and Aug. 4, 1920, pp. 5-12, 61-66, 105-109, 154-158 and 197-203, 24 figs. Study of factors influencing viscosity and jell strength. Relations between physical properties and chemical constitution and influence of size of molecule upon physical constants. Physical and chemical significance of "craze." It is concluded from experiments that strength of glue in service is function of jell strength, viscosity, and melting point. Melting-point method for evaluation of glues is suggested. Bibliography of manufacture, physical properties and tests of glues and gelatines is appended.

GOLD MINING

India

The Romance of Gold Mining in the Mysore State, E. W. T. Slater. Eng. & Min. Jl., vol. 110, no. 7, Aug. 14, 1920, pp. 302-305, 4 figs. Historical review of discovery of gold in Kolar gold field and inception of operations in this area, together with descriptions of industrial conditions.

GRAIN HANDLING

Unloader

New Grain Unloader Saves Time at Elevators. Ry. Age, vol. 69, no. 3, July 16, 1920, pp. 93-94, 3 figs. Device said to open car doors without injury or loss of time.

GRAPHITE

Preparation for Crucible Use

Mining and Preparing Domestic Graphite for Crucible Use, George D. Dub and Frederick G. Moses. Dept. of Interior, Bur. of Mines, bul. 112, 1920, 80 pp. 28 figs. Examination of deposits in Alabama and other states and survey of preparation and mining methods used. Account of experiments made to determine standard method of sampling and rapid but accurate method of analysis. Experimental work on concentration and refining of domestic crucible graphite to improve quality of product and to lessen waste.

GRAVEL

See SAND, Screening and Washing.

GRINDING MACHINES

Manganese-Steel Grinding

Grinding Manganese Steel, R. M. Johnson. Foundry, vol. 48, no. 16, Aug. 15, 1920, pp. 659-661, 9 figs. Description of installation of swinging-frame grinding machines.

GUNNERY

Naval

Naval Gunnery, Lord Congleton. Jl. Eng. Inst. of Canada, vol. 3, no. 8, Aug. 1920, pp. 379-383, 8 figs. Description of gun-director system.

H

HARBOR IMPROVEMENTS

Malay States

New Works for the Federated Malay States Government Railways. Engr., vol. 129, no. 3357, April 30, 1920, pp. 440-442, 11 figs. Works consist of reinforced-concrete jetty 1100 ft. long, coal wharf 900 ft. long, widening and reconstruction of existing wharf 600 ft. long, basin for vessels with 16 ft. depth at low water, dredging of channel and approaches to depth of 30 ft. below low water, and reclamation of swamps and foreshore.

HARDNESS TESTING

See TESTING MACHINES, Brinell.

HEAT

Electrically Generated

The Economical Utilization of Electrically Generated Heat (Ueber die sparsame Ausnutzung elektrisch erzeugter Wärme), H. Schneider. Elektrotechnischer Anzeiger, vol. 37, no. 42, Mar. 13, 1920, pp. 197-198, 2 figs. It is pointed out that through suitable insulation, proper arrangement and selection of heater material, and through skilful arrangement of manufacturing processes, the economical electric heating and, in many instances, a continuous utilization of the heat generated can be effected.

Solar, Origin of

On the Origin of Solar and Stellar Heat (Sur l'origine de la chaleur solaire et stellaire), Emile Belot. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 26, June 28, 1920, pp. 1563-1565. Suggests theory based on assumption that heat evolved from cosmic collisions is stored in sun and is being gradually radiated away.

HEAT STORAGE

See BOILERS, Electrically Heated.

HEATING

Progress in

Progress in the Heating Industry (Neues aus der Heizungsindustrie), H. Pradel. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol 43, nos. 8 and 10, Feb. 20 and Mar. 5, 1920, pp. 57-59 and 75-77, 27 figs. Details of Swedish, Danish, Rumanian, American and German patents for sectional boilers, dampers, sheet-steel, radiators, etc.

HEATING AND VENTILATION

Fan-Blast System

An Improved Fan Blast System of Heating and Ventilating, Albert R. Klein. Heating and Ventilating Magazine, vol. 17, nos. 7 and 8, July and Aug., 1920, pp. 29-33, 6 figs., and 29-33, 5 figs. Paper enumerates advantages gained in distribution of heat and fresh air, in reduction of heat losses and horsepower, and in costs of new fan-blast heating, ventilating or cooling systems if they are provided with special "circulating" air outlets. It is further shown that existing systems can be materially improved in regard to distribution of heat and air and that, in certain cases, an increase of heating capacity can be obtained by the application of these circulating outlets.

Noise Elimination in Systems

Elimination of Noises in Heating and Ventilating Systems—IV. Heat. & Vent. Mag., vol. 17, no. 8, Aug. 1920, pp. 33-35, 7 figs. Notes on cause, effect and prevention of mechanical, air and water hammer vibrations.

HEATING, FACTORY

Exhaust-Steam

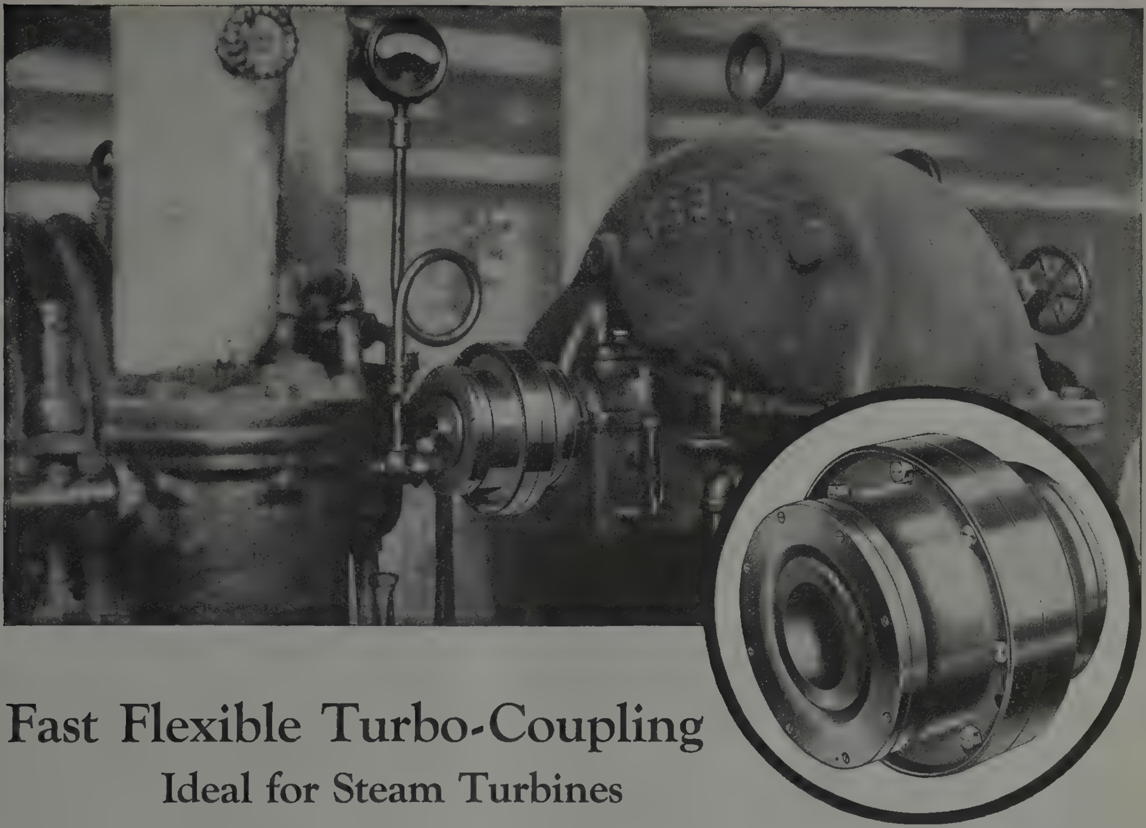
Factory Heating (Ueber Fabrikheizung), F. Kaiser. Zeitschrift des Bayerischen Revisions-Vereins, vol. 24, nos. 2 and 3, Jan. 31 and Feb. 15, 1920, pp. 9-10 and 21-23, 1 fig. Writer discusses most suitable heating practices and seeks to determine, in view of high cost of coal, under what conditions a factory power plant in which there would be an extensive utilization of exhaust steam would be preferable to the purchase of current.

HEATING, HOT-AIR

See HEATING and VENTILATION, Fan-Blast System.

HEATING, STEAM

See HEATING, FACTORY.



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ENGINEERING INDEX (Continued)

HEAVY-OIL ENGINES

English Types

Some Lincolnshire Oil Engines, F. H. Livens. Eng., vol. 110, no. 2848, July 30, 1920, pp. 159-162, 13 figs. Description of various types of heavy-oil engines, indicating developments in design from 1891 to 1919. Paper read before Instn. Mech. Engrs.

HOISTING MACHINERY

Efficiency

The Efficiency of Hoisting Machinery When Lowering the Load (Der Wirkungsgrad von Lasthebemaschinen beim Senken der Last), Leopold Feigl. Fördertechnik u. Frachtverkehr, vol. 13, nos. 6 and 7, Mar. 19 and Apr. 2, 1920, pp. 61-62 and 70-72. Points out that in hoisting machinery without warm gears the lowering capacity is not quite 1 per cent under hoisting capacity, or so slight as to be negligible. Account of experiments carried out to confirm calculated results. Basic conditions for the derived equations are given.

Standardization

Important Considerations in Regard to Standardization (Wichtige Gesichtspunkte bei Normalisierungen), R. P. Schröder. Fürdertechnik u. Frachtverkehr, vol. 13, no. 5, Mar. 5, 1920, pp. 50-52. Notes on basic principle of standardization of parts, with examples demonstrating suitable and tested applications; investigation of standards presented by German Engrs.; and suggestions for improvement of method now in use.

HOISTS

Electric

Modern Electric Hoists (Neuzelitliche Motorflaschenzüge), Ernst Blau. Fördertechnik u. Frachtverkehr, vol. 13, no. 5, Mar. 5, 1920, pp. 54-56, 2 figs. States their advantages and describes spur-gear electric hoist of the German Machine Works Corp. (Demag) in Duisburg, built for loads up to 5 tons.

Mine

A New Depth Indicator for Mine Hoists (Ein neuer Teufenzeiger für Fördermaschinen), Wilh. Weber. Fördertechnik u. Frachtverkehr, vol. 13, no. 4, Feb. 20, 1920, pp. 40-41, 1 fig. Device constructed by W. Weber & Co., Wiesbaden, for indicating exact position of cage, etc.

HOSE

Flexible-Metal

The Manufacture and Uses of Flexible Metal Hose (Der Metallschlauch, seine Herstellung und Verwendung), Metall-Technik, vol. 46, no. 11-12, Mar. 18, 1920, pp. 42-43, 10 figs. Usually made in lengths of 4 to 42 m. and up to 50 cm. diam. Suggestions for joining sections together, for protection against destruction and repair. Used for conveying coal, grain, ashes, etc.; distributing water, oil, gas, steam, etc.; for fire-extinguishing, suction dust collecting purposes, etc.

HOUSING

British Government's Scheme

The British Government's Huge Housing Scheme, E. J. Mehren. Eng. News-Rec., vol. 85, no. 5, July 29, 1920, pp. 217-218. Means being taken by British Government to promote and subsidize housing enterprises.

Industrial

Manufacturers' Housing Problems, Harold R. Watson. Can. Manufacturer, vol. 40, no. 8, Aug. 1920, pp. 47-52, 6 figs. Housing problem developed by Borders Housing Co., Canada.

HYDRAULIC TURBINES

Buckets

Increasing the Life of Turbine Buckets (Erhöhung der Lebensdauer von Turbinenschaufeln), Hans Schneider. Zeitschrift für das gesamte Turbinenwesen, vol. 17, no. 1, Jan. 10, pp. 8-9, 2 figs. Quotes suggestion of Schoop that metal-spraying process developed by him be applied to turbine buckets to increase their durability.

Pelton Type

Pelton Wheel Reconstruction, Percy Pitman. Eng., vol. 109, no. 2843, June 25, 1920, pp. 851-853, 13 figs. Reconstruction carried out at large ammunition works during war period to replace defective and broken buckets and to economize in water by fitting on buckets of more modern and efficient type.

Wear of

Wear of Hydraulic Turbines, its Consequences, and the Methods of Reducing It (L'usure des turbines hydrauliques, ses conséquénces et les moyens d'y parer), Henri Dufour. Bulletin Technique de la Suisse Romande, vol. 46, no. 12, June 12, 1920, pp. 133-140, 8 figs. Records of operation of sand settling basin in Switzerland. (Concluded.)

HYDROELECTRIC PLANTS

Efficient Operation

Effecting Efficient Operating Methods in Hydro-Electric Plants, L. W. Wyss. Power, vol. 52, no. 3, July 20, 1920, pp. 217-219. Based on experience in number of different hydroelectric stations located in various parts of the country.

Niagara Falls

Developing Niagara Falls Without Marring Its Beauty, J. G. Warren. Elec. World, vol. 76, no. 7, Aug. 14, 1920, pp. 329-331. Seven months of utilizing additional diversion of 20,000 sec-ft., showing comparative costs. 573,000 hp. to 787,000 hp. can be developed under these plans. Submerged weirs are proposed.

Regulating Prime Movers

Regulating Hydro-Electric Prime Movers, C. F. Mosher. Elec. World, vol. 76, no. 6, Aug. 7, 1920, pp. 280-281. Ability to hold constant speed, inherent regulation and momentary changes of speed are discussed in detail. Conditions upon which speed changes are based. From paper read before System Operators of New England.

Rhone-Rhine Possibilities

The Swiss Rhone-Rhine Navigation—V, A. Wharton Metcalfe. Engr., vol. 129, no. 3355, April 16, 1920, pp. 389-390, 2 figs. Hydroelectric aspect. Water power and generating stations. (Concluded.)

Switzerland

The Water-Power Plant on the Aar River (Die Wasserkraftanlage "Gösgen" an der Aare der A.-G. "Elektrizitätswerk Olten-Aarburg). Schweizische Bauzeitung, vol. 75, nos. 23 and 24, June 5 and 12, 1920, pp. 249-254 and 263-266, 16 figs. Details of turbine installation, generators and exciters, transformers (including technical data for the two transformer types), and water supply of plant. (Continuation of serial.)

[See also COMPRESSED AIR, Hydroelectric Plants.]

HYDROGEN

Electrolytic Production

Electrolytic Production of Hydrogen and Oxygen by the British Armies (La production de l'hydrogène et de l'oxygéne par électrolyse aux armées britanniques),T.-A. Ross. Revue générale de l'Electricité, vol. 7, no. 24, June 12, 1920, pp. 795-801, 10 figs. Details of installation near Rouen.

I

ICE PLANTS

Economical Operation

Economy at the Finney Avenue Ice Plant, St. Louis, C. Wilkie. Power, vol. 51, no. 25, June 22, 1920, pp. 990-994, 12 figs. Plant 14 years old, with mediocre equipment, is said to be operating at 58.6 per cent over its rated capacity and to be delivering average of 8.5 tons of ice per ton of 10,000-B.t.u. coal. Such performance is attributed to ingenuity of management, coöperation of operating force and careful manipulation of equipment.

INDUSTRIAL MANAGEMENT

Farming

Notes on Power Farming, R. W. Lohman. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 160-174 and 185, 36 figs. Paper discusses laying out of a production program, transportation of men and supplies, special implements for raw land preparation, tractor dynamometers, large tractors, special plowing and tilling implements, four-wheel-drive tractors and road haulage.

Production Control

Production Control Through a Routing Department, Norman G. Shidle. Automotive Industries, vol. 43, no. 7, Aug. 12, 1920, pp. 322-325, 6 figs. Operation of production control board and pneumatic-tube system by means of which, it is said, large machine-tool concern is keeping all its machines running efficiently.

Production Systems

Modern Production Methods, W. R. Basset. Am. Mach., vol. 53, nos. 1 and 5, July 1 and 29, 1920, pp. 17-20, 5 figs., and 215-219, 9 figs. Takes up planning of production so that all necessary parts of machines reach assembly floor at the same time. Discusses control of work in shop and describes "booth" system.

Organizing for Production—I. Eng. Production, vol. 1, no. 8, Aug. 1920, pp. 289-292, 4 figs. Procedure in American works manufacturing automobile carburetors.

Production Board at Marchant Calculating Machine Company. Metal Trades, vol. 11, no. 8, Aug. 1920, pp. 333-336, 6 figs. Production board devised to route work in such a way as to make it possible to determine at any time present status of any job in the factory, and to permit checking of costs at any time.

Production Planning and Tracing System. Iron Age, vol. 106, no. 4, July 22, 1920, pp. 183-185, 4 figs. System installed in Moreland Motor Truck Co.'s plant at Los Angeles, Cal. Follow-up record forms are illustrated.

The Lincoln Motor Production Plan—X. Methods of Receiving and Storing Material, I. J. Beatty. Factory, vol. 25, no. 1, July 1, 1920, pp. 38-41, 6 figs. How plant handles receiving and storing raw materials and completed parts so that production schedule is not held back.

Record Sheets

Piecework System by Which Clerical Work is Done Almost Entirely by Office Machines (Akkordsystem mit fast ausschliesslich durch Büromaschinen verrichtbaren Schreib- und Rechenarbeiten), Carl Rüsch. Werkstattstechnik, vol. 14, no. 6, Mar. 15, 1920, pp. 164-170, 12 figs. Gives illustrations of the various record sheets and describes system employed by machine-tool concern with 650 workmen, which manufacturers tools used in all the other workshops of a large plant.

Toolroom Organization

Toolroom System, E. E. Hirschhauter. Am. Mach., vol. 53, no. 8, Aug. 19, 1920, pp. 358-360, 9 figs. System said to have been in successful use for last five years in large gas-engine shop.

[See also TAYLOR SYSTEM; TIME STUDY.]

INDUSTRY

Socialization of

A German Industrialist's Views on Socialisation, Felix Deutsch. Eng., vol. 109, nos. 2838 and 2839, May 21 and 28, 1920, pp. 703-704 and 734-735. Facts and figures are presented which, it is claimed, demonstrate "that exaggerated demands by employees and workmen cannot bring them any benefit, but may in a measurable distance of time bring our (German) industry to a standstill, and themselves to unemployment."

INDUSTRIAL ORGANIZATION

English Works

The Organization of a Modern Engineering Works, with Some Observations Upon the Construction of Special Machinery, the Science of Production, the Training of Pupils and Trade Apprentices, and "Welfare," Richard W. Allen. Proc. South Wales Inst. of Engrs., vol. 36, no. 1, July 16, 1920, pp. 91-118. Based on organization of Messrs. W. H. Allen Sons & Co., Queen's Engineeriing Works, Bedford, England.

INLAND WATERWAYS

Size of, Determination

Determination of the Dimensions of Large Ships Intended for Inland Navigation, and of the Size to be Given to Inland Waterways (Détermination des dimensions des bateaux de navigation intérieure de fort tonnage, et du gabarit des voies navigables), Annales des Ponts et Chaussées, vol. 55, no. 2, March-April 1920, pp. 169-192. Study of comparative economy of carrying traffic in large ships and in barges. It is found that larger ships and waterways are more economical when traffic is in excess of 3,0000,000 tons per year. Memoir prepared by Committee appointed by French Ministry of Public Works.

INSPECTION

Factory

Inspection and the Modern Factory, O. B. Whittaker. Am. Mach., vol. 53, no. 7, Aug. 12, 1920, pp. 305-309, 6 figs. Organization of inspection department.

INSULATORS

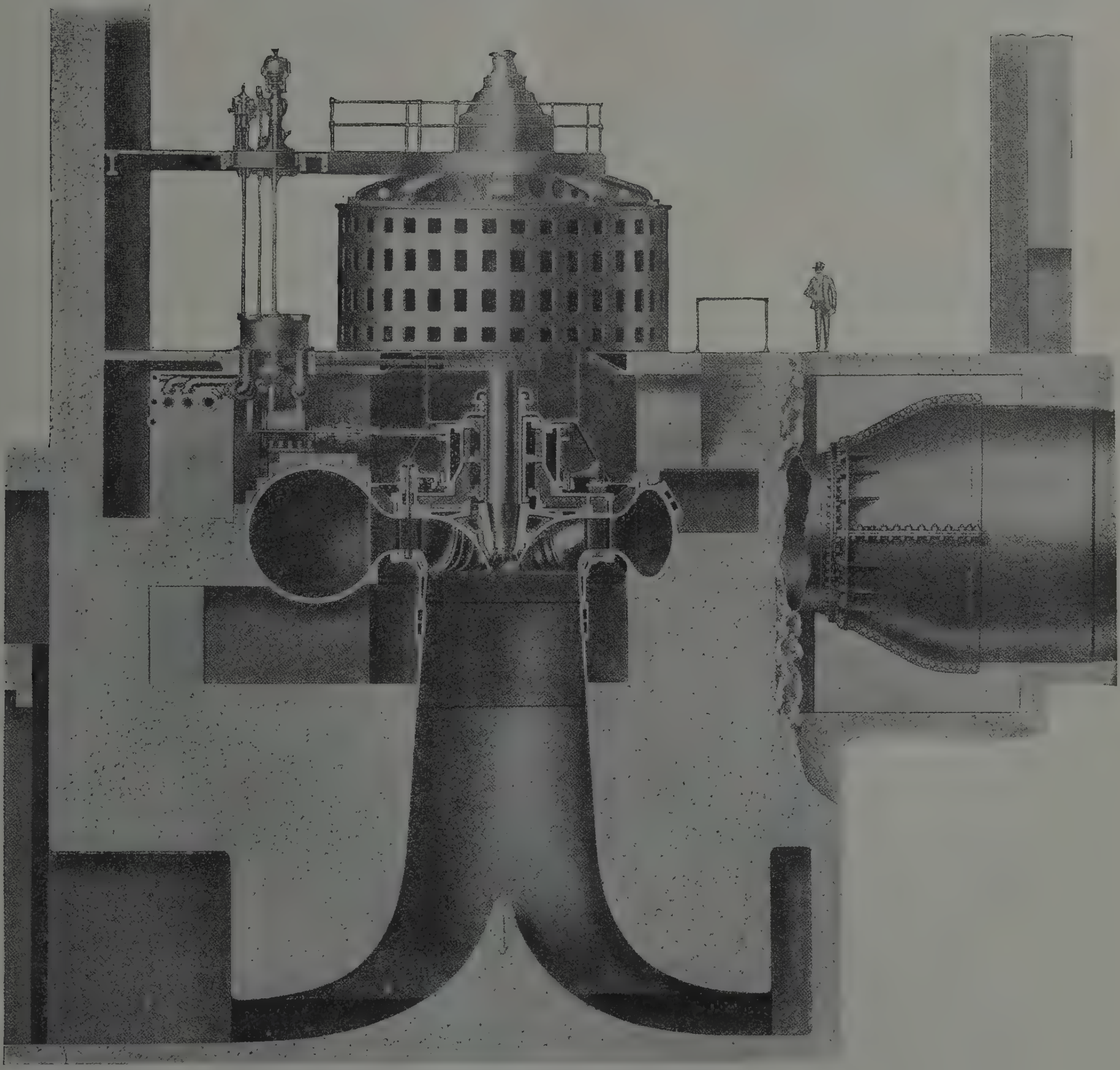
Paper Tubes

The Manufacture of Insulating Tubes and Accessory Parts (Herstellung von Isolierrohren und Zubehörteilen), R. Stock. Werkstattstechnik, vol. 14, nos. 4 and 5, Feb. 15 and Mar. 1, 1920, pp. 97-100 and 146-151, 122 figs. Details of an automatic roller-cutting machine for cutting paper rolls from which the insulating tubes are made; tube-molding machines for flexible tubes; revolving paper roll holder attached to molding machine for manufacture of spiral tubes; method and device used for impregnating tubes, etc. Sectional diagram of plant for manufacture of insulating tubes is shown.

I. P. Morris Hydraulic Turbines

The Wm. Cramp & Sons Ship & Engine Building Co.

Richmond and Norris Sts., Philadelphia



Two 37,500 Horse-Power Turbines built for the Hydraulic Plant of the Niagara Falls Power Co.

Three 55,000 Horse-Power Turbines are now under construction for the Niagara Development of the Hydro-Electric Power Commission of Ontario. These turbines are of the same type as above shown and will be the most powerful units ever built.

This company is now building Johnson Valves for the Larner-Johnson Valve & Engineering Company

ENGINEERING INDEX (Continued)

INTERCHANGEABLE MANUFACTURE

Gages for

Gages in Interchangeable Manufacturing—II, Earle Buckingham. Machy. (N. Y.), vol. 26, no. 12, Aug. 1920, pp. 1112-1117, 19 figs. Types of gages and gaging devices employed in manufacture of interchangeable parts.

INTERNAL-COMBUSTION ENGINES

Developments

Progress in the Field of Internal-Combustion Engines (Neuerungen auf dem Gebiete der Verbrennungskraftmaschine), Wirtschaftsmotor, nos. 2 and 3. Feb. and Mar, 1920, pp. 25-27 and 23-24, 28 figs. Details of device for cooling ports in 2-stroke internal-combustion engine; method of operation patented by the Berlin Construction Co., Ltd., by means of which greater power is obtained; new form of exhaust conduit for 2-stroke engines; by H. Baer, Breslau; new 2-stroke engine of H. Ganthier, Liege, Belgium; Daimler engine with three rows of cylinders; a combined starting and fuel valve of F. Krupp Corp., Kiel, etc.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; HEAVY-OIL ENGINES; KEROSENE ENGINES; OIL ENGINES.]

IONIZATION

Theory of

On the Theory of Ionization by Collision, P. O. Pedersen, Lond., Edinburgh, and Dublin Philosophical Mag. & Jl. of Sci., vol. 40, no. 325, July, 1920, pp. 129-137, 6 figs. Writer refers to assumptions by N. R. Campbell in article in this journal (vol. 23, 1912, p. 400) and claims he does not give exact solution, but claims exact solution, deduction of which is given, is quite simple and may be given a form to which Townsend's measurements may easily be applied, which is not true of the Campbell formula.

IRON

Reclamation from Non-Ferrous Materials

Reclaiming Iron from Non-Ferrous Materials, Hubert Hermann. Blast Furnace & Steel Plant, vol. 8, no. 8, Aug. 1920, pp. 442-445, 10 figs. Description of method of reclaiming iron from non-ferrous materials for remelting and to prevent damage to machines from pieces of iron.

IRON FOUNDING

Modern Practice

The Production of Good Iron Castings, Richard Moldenke. Iron Age, vol. 106, no. 4, July 22, 1920, pp. 191-193. Discusses sulphur problem, use of sea coal and selection of pig iron and scrap. (To be continued.) Address delivered at convention of Southern Metal Trades Assn.

IRON METALLURGY

Electric Smelting

Electric Smelting of Iron Ore with Coke, George Stig. Chem. & Met. Eng., vol. 23, no. 1, July 7, 1920, pp. 29-31. Gives data on run with coke which, it is said, demonstrated that electrometal furnace is suitable for operation with coke, and writer is of opinion that a correctly designed furnace of described type at present should give best results economically, and also that in order to obtain good results economically, large furnaces should be employed. Translated from Teknisk Ukeblad.

IRON MINING

Sweden

The Swedish Iron Mines of Kiruna and Gellivare, Charles W. Boise. Eng. & Min. Jl., vol. 110, no. 2, July 10, 1920, pp. 53-57, 6 figs. Large reserves of high-phosphorus, high-iron, magnetic ores, situated above Arctic circle are said to offer favorable mining and marketing conditions. Open-cut and underground methods followed by crushing and magnetic separation.

IRON ORE

Lake Superior District

The Future of the Lake Superior District as an Iron-Ore Producer, Edward W. Davis. Bul. of University of Minnesota, vol. 23, no. 18, May 22, 1920, 18 pp. Opinion is expressed that district can continue to produce immense tonnages of iron ore for many centuries by utilizing its low-grade ore material.

New Zealand

The Utilisation of Titaniferous Iron Ore in New Zealand, J. A. Heskett. Iron & Steel Inst., advance proof (meeting, May 6 and 7, 1920), 14 pp., 4 figs, 2 on supp. plate. Analyses of the two New Zealand ores are given, also analyses of iron produced, combined cinder and metallic ferrotitanium, etc. Author is convinced that TiO_2 will form up to 20 per cent of a slag, as proved in practice, and that this slag is as fusible as any blast-furnace slag.

K

KEROSENE ENGINES

Marine

Six-Cylinder 90-B.H.P. Paraffin Marine Motor. Eng., vol. 109, no. 2842, June 18, 1920, pp. 820-821, 9 figs. Crankshaft bearings are held in lower half of crankcase, caps being on top of shaft instead of beneath as is usual in motor car practice.

L

LABOR

American, Mobility of

Mobility of Labor in American Industry, Paul F. Brissenden and Emil Frankel. Monthly Labor Rev., vol. 10, no. 6, June 1920, pp. 36-56, 2 figs. Notes on definition and measurement of labor mobility; scope and limitations of the basic data; seasonal influences on labor mobility, and length of service as a factor: effect of employment policy on labor stability, etc. Summary review of bulletin to be published by Bur. of Labor Statistics.

Great Britain

What the British Worker is Thinking, Clarence H. Northcott. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 96-99. It is said that British worker "wants a richer and a fuller life, with a higher status and a more adequate recognition of himself as a human being," and it is pointed out that employers who do not recognize this "may expect industrial unrest, endless friction, diminished output and considerable trouble."

Hours of Work

The Hours of Work Problem in Five Major Industries. Natl. Industrial Conference Board, no. 27, March 1920, 91 pp. 2 figs. Summary of investigations thus far made by Nat. Industrial Conference Board of effects of changes in weekly hours of work on output and health of workers.

[See also TRADE UNIONS.]

LATHES

Turret

Hexagon Turret Lathe. Eng., vol. 110, no 2848, July 30, 1920, pp. 146-147, 4 figs. Machine designed specially for bar work. All movements are operated by power.

Libby Turret Lathe Practice. Machy. (N. Y.), vol. 26, no. 12, Aug. 1920, pp. 1132-1139, 23 figs. Tooling equipment employed by International Machine Tool Co., Indianapolis, Ind., in machining work on Libby turret lathe.

LIGHTING

Churches

The Artificial Lighting of Churches, John Darch. Illuminating Engr., vol. 13, no. 5, May 1920, pp. 142-157 and (discussion) pp. 157-163, 21 figs. Engineering technique and artistic aspect of problem are discussed and rules for church lighting are formulated.

Corona Lamps

Gaseous Conduction Light from Low-Voltage Circuits, D. McFarlan Moore. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 8, August 1920, pp. 733-742, 32 figs. Tests showed that efficiency of Corona lamps is the same whether operating on a-c. or d-c. circuits and the same on a-c. circuits over wide voltage range and wide range of intensities. Candle power was found to be greater with radiators of large area, and power factor to be about 85 per cent.

Street

Regulation of Street Series Lamps in Practice on Milwaukee's System, F. A. Vaughn. Jl. Western Soc. of Engrs., vol. 25, no. 11, July 20, 1920, pp. 374-403, 29 figs. Scheme of connections and records of operation.

Tendencies in Ornamental Street Lighting, L. A. S. Wood. Elec. World, vol. 76, no. 7, Aug. 14, 1920, pp. 324-325, 1 fig. Parkway system is discussed and suggestions regarding installation are made.

LIGNITE

Briquetting

Advantages of Coal-Handling Equipment for Use Over the Drying Apparatus in Lignite Briquetting Works (Ueber die Wirtschaftlichkeit einer Zuführungsvorrichtung auf den Kohlenböden über den Trockenapparaten in Brikettfabriken). Otto Schuster. Braunkohle, vol. 18, no. 49, Mar. 6, 1920, pp. 653-654. Describes Schuster apparatus used successfully in number of works with which it is possible to obtain increased and regular amount of dried product, and which prevents bulging and heaping of coal above the opening for receiving coal in drying apparatus.

Driers

The Completeness of the Evaporation Obtained in the Large Driers Used in Lignite Briquetting Works (Die Vollständigkeit der Verdunstung beim Grosstrockner der Pressbraunkohlenwerke), G. Achilles. Braunkohle, vol. 18, no. 47, Feb. 21, 1920, pp. 621-623. Points out that to obtain economic operation of a large drying apparatus the evaporation should be as complete as possible with a minimum of excess air.

[See also MINE HOISTING, Bucket Elevator for.]

LIME

Hydrated

Test Data on Lime in Concrete and Mortar, Tyrrell B. Shertzer. Nat. Lime Assn., bul. no. 303, 1920, 19 pp. 4 figs. Study of certain tests and experiments upon effects of hydrated lime when added to concrete mixtures under varying conditions and for various purposes, together with comments and field observations.

LOCOMOBILES

Compound with Superheater

Compound Locomobile with Superheater. Eng., vol. 109, no. 2840, June 4, 1920, pp. 766-768, 8 figs. Engine is two-cylinder compound mounted on cylindrical tubular boiler. Cylinders are 13 in. and 25 in. in diameter by 22 in. stroke. Valves are of balanced piston type. Engine is built by Messrs. Marshall, Sons & Co., Ltd., Gainsborough.

LOCOMOTIVE BOILERS

Table Grates vs. Finger Grates

Report on Front Ends, Grates and Ash Pans. Ry. Mech. Engr., vol. 94, no. 7, July 1920, pp. 450-452. Report presented to Railway Fuel Association. Describes tests made to determine what, if any, saving could be effected by using table grates in place of finger grates in locomotives burning Gallup coal. Saving was small, considerable loss being due to necessity of replacing finger-grate bars, because fingers burned off.

LOCOMOTIVES

Axle Loads

A New Method for Determination of Axle Loads for Locomotives on More than Two Supports (Neues Verfahern zur Bestimmung der Achsbelastungen für Lokomotiven auf mehr als zwei Stützen), J. Jrotschek. Annalen für Gewerbe u. Bauwesen, vol. 86, nos. 4 and 5, Feb. 15 and Mar. 1, 1920, pp. 25-31 and 33-40, 22 figs. Describes method and gives extended calculations for a rigid axle on three, four and any given number of elastic supports.

Bagasse-Burning

Burning Bagasse, Clark Y. McGown. Combustion, vol. 3, no. 2, August 1920, pp. 22-24, 1 fig. Author shows that principles involved and results secured in burning bagasse are very similar to coal burning.

Carbocoal for

Use of Carbocoal on Locomotives, George E. Scherick, Jr. Ry. Mech. Engr., vol. 94, no. 7, July 1920, pp. 452-453. Tests showed that carbocoal has many advantages, one of the chief of them being that it is a smokeless fuel. Paper read before Railway Fuel Association.

Cylinders, Welding

Repairing Locomotive Cylinders by Means of Oxy-Acetylene Welding (Ausbesserung von Lokomotivzylindern mittels der Acetylen-Sauerstoffschweissung). Autogene Metallbearbeitung, vol. 13, no. 4, Feb. 15, 1920, pp. 40-44, 12 figs, and Acetylen, vol. 23, no. 2, Feb., 1920, pp. 11-15, 12 figs. Describes various examples of repair work carried out by the firm of Samesreuther & Co., Butzbach.

English

Great Northern Three-cylinder Engine No. 1000. Engr., vol. 129, no. 3358, May 7, 1920, pp. 466-472, 12 figs. Dimensions: cylinders, 18½ x 26 in.; total heating surface, 2308 sq. ft.; tractive effort at 85 per cent boiler pressure, 30,031 lb.; total adhesive weight, 134,400 lb. Record of trial run is included.

L. and S. W. Ry. New Goods Locomotive. Engr., vol. 129, no. 3357, April 30, 1920, p. 458, 2 figs. Dimensions: Tractive effort at 85 per cent boiler pressure, 28,200 lb.; coupled wheels, diameter on tread 5 ft. 7 in.; class, 4-6-0; valve gear type, Walschaerts'.

Exhaust of

The Exhaust of Locomotives, F. Legein. Bul. of International Ry. Assn., vol. 2, no. 5, June 1920, pp. 319-359, 22 figs. Discusses

For Tar and Oil Conveyance

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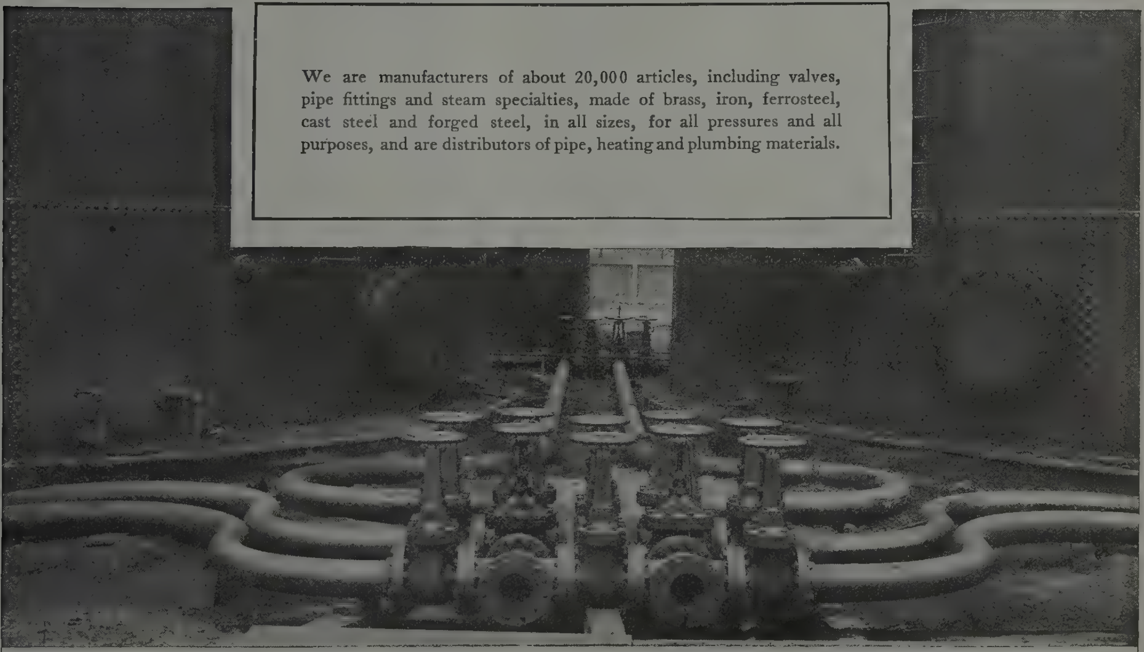

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proper proportions and arrangement of blastpipe and funnel, case of fluids of different densities, use of successive nozzles, complete arrangement, and relative arrangements of blastpipe and chimney, including form of jet.

Fuel Economy

Locomotive Fuel Economy and Smoke Prevention. Canadian Ry. & Marine World, no. 270, Aug. 1920, pp. 415-423, 11 figs. Report presented by Committee on Fuel Economy and Smoke Prevention at meeting of Mechanical Section. Am. Railroad Assn.

Fuel Tests

Locomotive Fuel Tests on the Great Central Railway. Ry Gaz., vol. 33, no. 2, July 9, 1920, pp. 60-62, 1 fig. Results obtained with locomotives equipped for burning ordinary coal, colloidal fuel, and pulverized coal.

Oil vs. Coal-Burning

Santa Fe Locomotive Oil Burning Practice and Fuel Performance, Walter Bohnstengel. Ry. Mech. Engr., vol. 94, no. 7, July 1920, pp. 449-450. Santa Fe System has approximately 3160 locomotives, of which two-thirds use coal and one-third use oil as fuel. Tests show evaporate efficiency of oil is about 25 per cent more than coal for hand-fired and 40 per cent more than coal for stoker-fired locomotives; Also showed that installation and maintenance of brick arch cannot be justified in oil-burning locomotives. From paper read before Railway Fuel Association.

Steam Separators for

Purification of Steam for Locomotives (Reinigung des Dampfes für Lokomotiven und deren Wirtschaft), Ewald Mees. Organ für die Fortschritte des Eisenbahnwesens, vol. 57, no. 5, Mar. 1, 1920, pp. 68-71, 2 figs. Points out defects in devices such as the Kappe's baffle used on the Prussian and Hessian railroads, and describes centrifugal steam separator patented by author and constructed for locomotives and stationary boilers, consisting of a cylindrical vessel in which steam enters and is conducted through a spiral-shaped conduit until it reaches outlet in the center.

LUBRICANTS

Standard

Government Standards for Oils and Greases. Power, vol. 52, no. 3, July 20, 1920, pp. 99-103, 1 fig. Abstract of report of U. S. Government's committee on Standardization of Lubricants.

LUBRICATING OILS

Specifications

Writing Specifications for Lubricating Oils and Greases, A. A. Potter and A. J. Mack. Elec. World, vol, 76, no. 6, Aug. 7, 1920, pp. 281-282. General properties of oils which have bearing on specifications. Typical specifications for turbine, dynamo and other oils.

Voltol

Friction in Journal Bearings When Lubricated by Mineral Oil to which Voltol Has Been Added and under Variation of Speed and Temperature (Die Reibung in Gleitlagern bei Zusatz von Voltol-Oel zu Mineralöl und bei Veränderung der Umlaufzahl und der Temperatur), C. Biel. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 25 and 26, June 19 and 26, 1920, pp. 449-452 and 483-485, 9 figs. It is demonstrated by a number of tests carried out in 1915 at the Technical High School, Carlsruhe, that a mixture of mineral oil and "voltol" acts differently from pure mineral oil of the same viscosity and reasons therefor are given. Gives some new expressions for dependence of friction on speed, temperature and viscosity, which are said to agree with those of former researches.

LUBRICATION

Germ Process

The Germ Process of Lubrication, Henry M. Wells and James Ed Southcombe. Ry. Rev., vol. 67, no. 2, July 10, 1920, pp. 45-48. It is demonstrated by laboratory processes that increased value of compounded oils is due to presence in them of fatty acids introduced as impurities with vegetable or animal oils added to mineral oil as per formula or specification. By addition of fatty acids, it is said, authors have been able to duplicate and even improve on results yielded by compounded oils and with a degree of economy measured by cost of vegetable and animal oils formerly employed. From paper read at Nat. Petroleum Assn.

M

MACHINE SHOPS

English

The Works of Messrs. Clayton and Shuttleworth, Ltd., at Lincoln. Eng., vol. 109, nos. 2840 and 2841, June 4 and 11, 1920, pp. 741-747, 30 figs., and 778-801, 11 figs. Steam and electric road tractors, railway rolling stock, drop stampings and steel forgings are manufactured in works.

The Works of Messrs. Marshall, Sons and Co., Ltd., Gainsborough. Eng., vol. 109, nos. 2837 and 2838, May 14 and 21, 1920, pp. 635-641 and p. 652, 24 figs., and 670-675 and 686, 20 figs. partly on 3 supp. plates. Historical account of development. Works manufacture portable engines, road rollers, traction engines, locomobiles, fixed engines, etc.

The Works of Messrs. William Foster and Co., Ltd., Lincoln. Eng., vol. 109, no. 2843, June 25, 1920, pp. 847-850, 15 figs. partly on 4 supp. plates. Tractors, road locomotives, threshing machines, and other farm machinery are constructed. War tanks were developed in these shops.

MACHINE TOOLS

German

The Special Exhibition of German Machine Tool Construction at Leipzig in March, 1920 (Die Sonderausstellung des deutschen Werkzeugmaschinenbaus in Leipzig in März 1920). Werkstattstechnik, no. 5a, special Leipzig Exposition issue, 1920, 23 pp., 45 figs. Details of various machine-tool exhibits of 45 German factories.

Herringbone Gears for

Herringbone Gears for Machine Tools, Nikola Trbojevich. Machy. (N. Y.), vol. 26, no. 12. Aug. 1920, pp. 1164-1169, 6 figs. Advantages gained by use of herringbone gears and methods employed in cutting them.

Provision for Repairs

A Plea for Better Harmony Between Theory and Practice—III. Machy. (London), vol. 16, no. 410, Aug. 5, 1920, pp. 546-548, 5 figs. Examples of faulty designs of machine tools lacking accessibility for making repairs.

Spindles and Bearings

Recent Machine Tool Developments—XIII, Joseph Horner. Eng., vol. 109, no. 2839, May 28, 1920, pp. 707-710, 19 figs. Spindles and bearings of machine tools.

MAGNESIUM ALLOYS

Dow Metal

The New Alloy of Magnesium, E. J. Jenkins. Iron Age, vol. 106, no. 4, July 22, 1920, pp. 193-194, 3 figs. Dow metal manufactured by Dow Chemical Co., Midland, Mich., said to be lighest metal known which is adapted to commercial uses. Alloy is said to be manufactured electrolytically from magnesium chloride.

MAGNETIZATION

Neutral

Neutral Magnetization in Iron, Arthur W. Smith and Harry E. Hammond. Physical Rev., vol. 15, no. 4, sec. series, Apr., 1920, pp. 249-255, 4 figs. Gives results of experiments showing that iron, when brought to zero point along any hysteresis curve, is in a definite state of magnetization, even though neutral; in this condition the iron has a greater permeability than when it is demagnetized to zero point by slow reversals of a gradually decreasing magnetomotive force.

MAGNETOS

French Machines

Magneto Industry in France (L'industrie de la magnéto d'allumage en France), H. W. Porret. Technique Moderne, vol. 12, no. 1, Jan. 1920, pp. 25-28, 17 figs. High-tension machines. (Continuation of serial.)

Wyco Type

Two Types of Magneto that Employ the Magnetic Bridge Principle. Automotive Industries, vol. 43, no. 6, Aug. 5, 1920, pp. 256-257, 4 figs. Wyco magnetos. One has reciprocating armature and in the other armature is on periphery of flywheel.

MALLEABLE CASTINGS

Annealing

Anneal Malleable in Tunnel Kiln, H. E. Diller. Foundry, vol. 48, no. 16, Aug. 15, 1920, pp. 638-644, 11 figs. Kiln of tunnel type used for continuous annealing at plant of Saginaw Malleable Iron Co.

MARINE ENGINES

Forced Lubrication

Forced Lubrication for Marine Engines, W. C. Owen. Int. Marine Eng., vol. 25, no. 8, Aug. 1920, pp. 662-664, 2 figs. Application of forced lubrication to reciprocating engines; arrangement for oiling main bearings, crank pins and crossheads.

Still vs. Sulzer Types

"Still" and "Sulzer" Marine Engines, William Denny. Eng., vol. 110, no. 2846, July 16, 1920, pp. 98-100, 8 figs. Comparative trials of Still and Sulzer engines under actual working conditions on board ship. Paper read before Instn. Naval Architects.

[See also DIESEL ENGINES; KEROSENE ENGINES.]

MARINE FITTINGS

Characteristics

Marine Brass Goods and Fittings, Peter W. Blair. Metal Industry (N.Y.), vol. 18, no. 8, Aug. 1920, pp. 351-352, 6 figs. Characteristics of marine fixtures as distinguished from standard lines.

MEASURING MACHINES

Universal

Universal Measuring Machine. Engr., vol. 129, no. 3358, May 7, 1920, pp. 472-473, and p. 476, 9 figs. partly on 2 supp. plates. Type designed by Société Genevoise d'Instruments Physique of Geneva, which is said to enable absolute measurement to be made with accuracy of 0.00005 in.

METAL SPRAYING

Methods

Metal-Spraying Methods in Art and Industry (Die Metallspritzverfahren in Kunst und Industrie). Der praktische Maschinen-Konstrukteur, vol. 53, nos. 7 and 9, Feb. 19 and Mar. 4, 1920, pp. 27-30 and 36-38, 3 figs. Deals with Schoop metal-spraying process and the various discoveries of Thurston, Morf, and others.

METALS

Testing

Mechanical Testing of Metals (La pratique des essais méchaniques des métaux), Jean Durand. Génie Civil, vol. 77, no. 1, July 3, 1920, pp. 8-11. 4 figs. Rules defining testing practice, formulated by Commission permanente de Standardization.

X-Ray Studies

Some Studies of Metals by Means of X-Rays, S. Nishikawa and G. Asahara. Physical Rev., vol. 15, no. 1, sec. series, Jan., 1920, pp. 38-45, 18 figs. on 3 supp. plates. By passing a narrow beam of heterogeneous rays through a thin sheet of metal, a pattern may be photographically recorded which depends on crystalline structure of metal. Authors have used this phenomenon to study effect of rolling and subsequent annealing on various metals, and results are given in the case of various metals. It was shown that the various metals differ greatly in their response to annealing.

METEOROLOGY

Aeronautics, Relation to

Meteorology and Aeronautics. Air Service Information Circular, vol. 1, no. 77, May 12, 1920. 8 pp., 2 figs. Location and layout of flying fields, exploration of upper air, forecasts, light charts and magnetic charts.

METRIC SYSTEM

Introduction in American Factory

The Metric System in an American Factory, Theodore H. Miller. Machy. (N. Y.), vol. 26, no. 12 Aug. 1920, pp. 1128-1129. How DeLaval Separator Co. changed from English to metric system. Change was effected in order to keep better in line with Swedish establishment manufacturing same machines and was made without causing confusion, or serious disturbance. It was not necessary to throw away patterns, gages or tools made to the English system.

MILLING

Power Consumed in

Power Consumed in Milling. Fred A. Parsons. Am. Mach., vol. 53, no. 7, Aug. 12, 1920, pp. 315-316, 1 fig. Investigation of variables affecting power consumed in milling was undertaken for purpose of constructing slide rule which would indicate for various cuts power required, and therefore, machine best adapted for job. Data were obtained in tests made by Kempsmith Manufacturing Co. on various Kempsmith millers.

MINE HOISTING

Bucket Elevator for

Hoisting by Means of Bucket Elevator at the Lignite Mines of the A. Riebeck Works, Inc. [Schachtförderung mittels Becherwerks auf der Braunkohlengrube Gottlob (bei Theissen) der A. Riebeckschen Montanwerke, A.-G.], Ottmar Aockerblom. Braunkohle, vol. 18, no. 49, Mar. 6, 1920. pp. 647-653, 2 figs. Details of construction, operation and cost of installing.

Number Six of a Series

Working Points

(Not Talking Points or Selling Points)

of the Hartness Flat Turret Lathe

Quick Positive Feed Changes

If the Operator has to leave his working position and travel to another point on the machine to get a desired feed change, he will not make it.

If he has to stop the feed or stop the spindle to get a desired feed change, he probably will not make it.

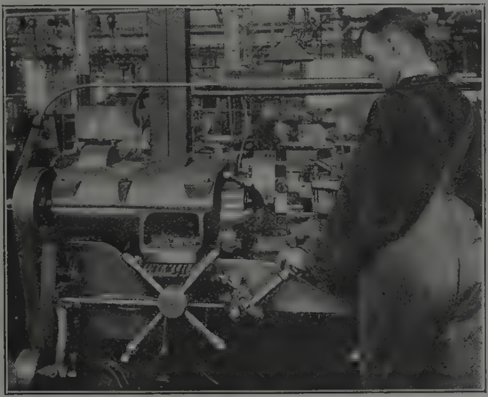
On the Hartness Flat Turret Lathe the operator will use the proper feed because it is so easy to get it.

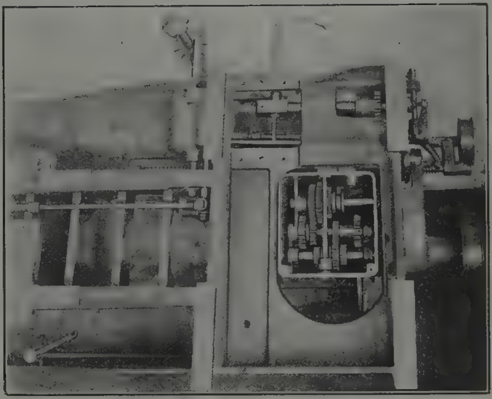
Turn down the feed lever, rotate until dial shows feed desired, and push it up again. That is all. No stopping the spindle, no stopping the feed. The cut goes right on.

The feed change is by hardened steel gears, running in oil. Just like an automobile transmission.

Feeds that feed and Stops that stop—are found in

The Hartness Flat Turret Lathe





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SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

ENGINEERING INDEX (Continued)

MINE LOCOMOTIVES

Combination Storage Battery and Trolley

How to Operate Combination Storage Battery and Trolley Locomotives, John B. Hicks. Coal Age, vol. 18, no. 2, July 8, 1920, pp. 59-62, 4 figs. Practical instructions for motormen, repairmen, superintendents and foremen, intended to enable them to keep their equipment continuously in running order. Use of constant current and constant potential in charging. From paper read before Kentucky Min. Inst.

MINES

Rescue Apparatus

The Mine Rescue Apparatus Research Committee. Colliery Guardian, vol. 120, no. 3109, July 30, 1920, pp. 312-314. Experimental results obtained in Edinburgh during last two years, and description of new or improved methods and apparatus which are outcome of investigation. (To be continued.)

Safety

Use of Stenches as a Warning in Mines, S. H. Katz, V. C. Allison and W. L. Egy. Dept. of Interior, Bur. of Mines, technical paper 244 1920, 31 pp. 5 figs. Opinion is stated that placing of stenches in compressed-air lines of mine to warn miners of danger offers certain advantages over use of electric bells or other means of warning. Of 24 chemicals examined, butyl mercaptan, ethyl mercaptan, amyl acetate, butyric acid and valeric acid were found most promising for mine warnings.

Shaft Illumination

Recent Improvements in the Illumination of Mine Shafts (Die neueren Fortschritte der Grubenbeleuchtung). Elektrotechnischer Anzeiger, vol. 37, no. 31, Feb. 24, 1920, pp. 147-148, 2 figs. Describes new patented construction by Schneider & Co., Frankfurt, in which the opening of a hinged lamp-protecting globe cuts off current from the incandescent lamp before the explosive firedamp can enter.

Shaft Houses

Building Reinforced-Concrete Shaft Houses, J. Ellzey Hayden and Lucien Eaton. Min. & Metallurgy, no. 164, Aug. 1920, pp. 25-26, 2 figs. Plan adopted at Cliffs shaft mine of Cleveland Cliffs Iron Co., Ishpeming, Mich., calling for reinforced-concrete building 33 ft. square inside at ground level, with solid vertical walls for 31 ft., then tapering to 21 ft. square at eaves at height of 88 ft. 9 in., with pyramidal roof. (Abstract.)

Ventilation

Mechanical Ventilation at Lake Mine, Lucien Eaton. Min. & Metallurgy, no. 164, Aug. 1920, pp. 28-29, 1 fig. Air goes down airshaft to 415-ft. sublevel, where it is split in two and passes up to 398-ft. sublevel through raises. Ventilation of stopes along route of air current is by diffusion aided by movement of cars and by some leakage through caved ground. An average of 225 cu. ft. per minute per man is provided. (Abstract.)

MINING

Athens System

Athens System of Mining, S. R. Elliott. Min. & Metallurgy, no. 164, Aug. 1920, pp. 23-24, 4 figs. Mining methods at Athens mine, 2500 ft. deep. (Abstract.)

China

Mineral Enterprise in China, Thomas T. Read. Eng. & Min. Jl., vol. 110, no. 7, Aug. 14, 1920, pp. 298-301, 4 figs. Difficulties foreign operator must contend with. It is said that there are small possibilities of discovering extensive ore deposits, and that development of properties is hindered by lack of transportation facilities.

Siberia

The Mining Opportunities in Siberia Under the Present Régime of Zemstvo-Soviet Government, Ivan Narodny. Eng. & Min. Jl., vol. 110, no. 7, Aug. 14, 1920, pp. 306-308. Author states that although mining enterprises will be under control of government there is "a fine opportunity and an enormous field for the new activity."

MOLYBDITE

Deposits, U. S.

Molybdite: Its Occurrence, Detection and Determination in Partly Oxidized Molybdenite Ores, J. P. Bonardi. Chem. & Metallurgical Eng., vol. 23, no. 5, Aug. 4, 1920, pp. 205-206. Review on composition of molybdite ore, its occurrence and concentration. Chemical test for molybdite in presence of molybdenite. Outline of methods for qualitative and quantitative analysis.

MONEL METAL

Casting

Pointers on Casting Monel Metal, Reginald Trautschold. Foundry, vol. 48, no 16, Aug. 15, 1920, pp. 649-651, 4 figs. Difficulties to be met by reason of high melting point and large shrinkage.

Machining Castings

Machining Monel-Metal Castings, A. J. Hanlon. Am. Mach., vol. 53, no. 8, Aug. 19, 1920, pp. 341-343, 6 figs. Specifications for lathe tools for turning and threading monel-metal castings.

MORTARS

Cement-Lime

Ideal Brick Mortar, James S. Macgregor. Nat. Lime Assn., bul. no. 300, 1920, 29 pp. 13 figs. Results of experiments made at Columbia University. Object was to indicate what value, from standpoint of strength, better bearing surface given to bricks possessed when laid up with cement-lime mortars of varying proportions, and to determine practical effect of strength when bricks absorbed portion of moisture from mortar and thus robbed mortar of moisture needed to hydrate and harden cement.

Fireclay

Fireclay Mortars for Laying Fireclay Brick, Raymond M. Howe. Chem. & Metallurgical Eng., vol. 23, no. 6, Aug. 11, 1920, pp. 232-234, 7 figs. Experiments conducted at Mellon Inst. of Industrial Research. Data obtained show that addition of lime, portland cement, asbestos, and salt affects quality of fireclay, addition of only 5 per cent of these materials lowering fusion point about 200 deg. fahr. Waterglass and carborundum did not exert so marked an influence.

MOTOR-TRUCK TRANSPORTATION

Coal

What the Deep Vein Coal Co. Has Learned About the Ship-by-Truck Movement, Donald Baker. Coal Age, vol. 18, no. 6, Aug. 5, 1920, pp. 278-281, 2 figs. It is said that five-ton motor trucks are able to haul coal for short distances cheaper than railroads and can deliver it to customer's cellar for much less than combined rail and wagon charge.

Comparison with Railways

Motor Truck vs. Railway (Lastkraftwagen oder Eisenbahn?), H. Christfreund. Verkehrstechnik, vol. 37, no. 6, Feb. 25, 1920, pp. 77-80, 2 figs. Investigation of the experience of extending railroad system by branch lines consisting of motor trucks. Tables giving transportation costs per ton-km. of the most important, commoner kinds of bulk freight transported by railroad and by a 5-ton Benz steel-tired motor truck with 44- to 50-hp. engine, and running at a speed of 15 km. per hr., together with overhead costs, etc.

Electric

Electric Truck Transportation as Developed in Germany, Ernst Valentin. Automotive Industries, vol. 42, no. 4, July 22, 1920, pp. 162-167, 16 figs. Problem of transporting goods and foodstuffs in interior where supply of gasoline is low and skilled drivers scarce. Heavy electric truck chosen as solution. Principal feature is standardized storage battery and charging methods adopted.

Long-Distance Haul

Saving a Ton on the Long-Distance Truck Haul. Automotive Industries, vol. 43, no. 7, Aug. 12, 1920, pp. 308-310 and p. 320, 5 figs. It is claimed that truck often carries unnecessary load because body is improperly designed. Considerations of body design with a view to diminishing weight are presented.

Gasoline vs. Steam Vehicle

Road Transport by Steam Vehicles, P. W. Robson. Eng., vol. 110, no. 2847, July 23, 1920, pp. 123-126, 9 figs. Comparative costs of hauling five tons per mile by various steam and gasoline cars are given and it is estimated that annual saving over 15,000 miles by use of steam against gasoline vehicles is $5000 per vehicle. Paper read before Instn. Mech. Engrs.

MOTOR TRUCKS

German

Analysis of German Trucks by the Motor Transport Corps, W. E. Noakes. Automotive Industries, vol. 42, no. 23, June 3, 1920, pp. 1250-1252, 3 figs. Details of the Arbenz engine, which is four-cylinder, 4⅛ by 6 in. bore and stroke, 4-point suspension, suspension by upper half of crankcase. It is said that good judgment has been shown in designing this type in regard to service, as all parts are accessible. Report on trucks surrendered to A.E.F. (Continuation of serial.)

Scammell

The Scammell Chassis. Automobile Engr., vol. 10, no. 140, July, 1920, pp. 268-271, 10 figs. Interesting features of a British design embodying low chassis weight with carrying capacity as high as 7½ tons.

Specifications

Internal-Combustion Truck Specifications. Power Wagon, vol. 24, no. 189, Aug. 1920, pp. 30-49. List of American trucks from 500 to 2000 tons capacity.

Spring Wheels for

Spring Wheels for Motor Trucks (Federnde Räder für Lastkraftwagen), Rud. Urtel. Motorwagen, vol. 23. nos. 5 and 6, Feb. 20 and 29, 1920, pp. 83-90 and 112-122, 40 figs. Account of tests to determine effect of springs inside of metal tires of motor-truck wheels as a substitute for rubber tires. Results show that the springs exert influence only at high speed, and the stiffer the spring, the greater the speed at which its influence begins to take effect. Possibilities of improvements of spring wheels are suggested.

Types for Special Purposes

Modern Motor-Truck Types for Special Purposes (Moderne Lastwagentypen für besondere Zwecke), Albert Neuburger. Allgemeine Automobil-Zeitung, vol. 21, no. 8, Feb. 21, 1920, pp. 21-22, 5 figs. Details of a brick transportation truck of the Mannesmann Mulag Motor Truck Corp. and the H. Büssing truck, both constructed with a view to reducing time of loading and unloading; a new type of truck for transportation of alcohol and a truck for transportation of implements, both of the Nat. Automobile Corp.

MOTORSHIPS

Diesel-Engined

The Motor Ship "Narragansett." Eng., vol. 109, no. 2839, May 28, 1920, pp. 716-719 and p. 722, 18 figs. partly on 2 supp. plates. Deadweight capacity, 10,050 tons; draft, 26 ft.; cargo-carrying capacity, 9450 tons. Vessel is oil tanker and contains 10 main-cargo oil tanks divided longitudinally by center bulkhead and fitted with trunk hatches to upper deck, each hatch having a vent pipe.

Electrically Welded

The Electrically-Welded Ship "Fullagar." Eng., vol. 10, no. 2844, July 2, 1920, pp. 25-26, 14 figs. Dimensions: Length, 150 ft.; beam, 23 ft. 9 in.; depth, main deck, 11 ft. 6 in.; draft, 11 ft. 4 in.; deadweight, 500 tons, cargo capacity, 25,200 cu. ft.; speed, 9½ knots to 10 knots. Welding was carried out by quasi-arc system. Tests at sea are said to have proven motorship to be entirely satisfactory.

N

NATURAL GAS

Casing-Head

Valuation Factors of Casing-Head Gas Industry, Oliver U. Bradley. Min. & Metallurgy. no. 164, Aug. 1920, pp. 27-28. Most important factors are said to be quantity of gas available and conditions that will have material bearing on its future supply, such as location of field, depth of oil wells, initial rock pressure, thickness and porosity of oil sands, relative position of oil and gas strata in sand, grade of oil, life of oil wells, location and rapidity of water infiltration, vacuum carried, and regularity of its application. (Abstract.)

Kansas and Oklahoma

A Chemical Survey of the Natural Gases of Kansas and Oklahoma, H. C. Allen and E. E. Lyder. Bul. of University of Kansas, vol. 19, no. 1, Jan. 1, 1918, 101 pp. 10 figs. It is shown that gases of Mid-Continental field vary between wide limits—99 per cent to 10 per cent—as to percentage of hydrocarbons and nitrogen present, and consequently in heating values. Maximum percentage of carbon dioxide found was slightly over 4 per cent. Shallower gases were found to be poorer in quality than deeper ones in the same locality.

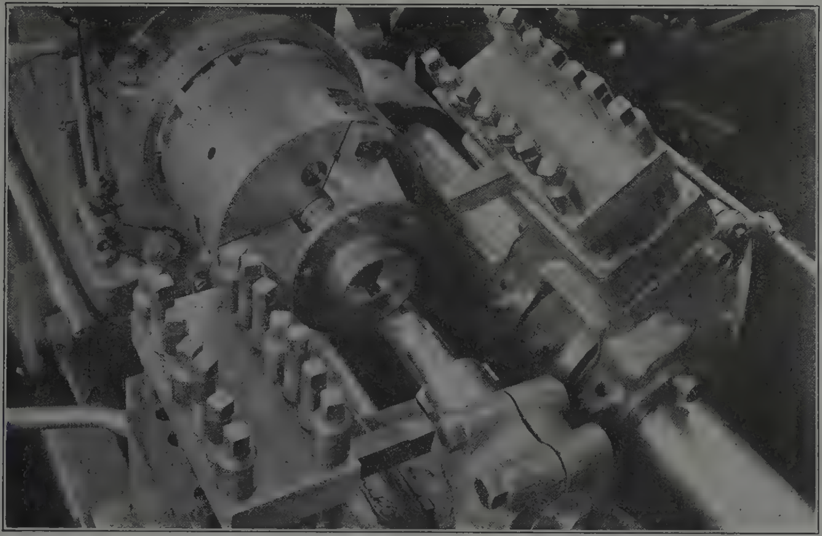
[See also PIPE LINES, Natural-Gas Transportation.[

NICKEL METALLURGY

Smelting

The Mining and Smelting Operations of the International Nickel Company of Canada, Limited. Monthly Bul. Can. Inst. Min. & Metallurgy, no. 100, Aug. 1920, pp. 614-654, 30 figs. Method of treating ore, including roasting, smelting in blast furnace or reverberatory, and converting matter in basic converters. Detailed account of operation is given, together with description of machinery. (Concluded.)

The FAY WAY *of*
Machining an Automobile Hub



The above photograph shows the method of boring and facing an automobile hub on the Fay Automatic Lathe.

A special boring attachment is clamped to the center bar. The fixture is held in position by arms resting and riding on the machine ways.

The back arm rocks in and faces.

The front carriage rocks in and chamfers.

One man runs two machines.

A fast operation on a swift, accurate machine, at a low labor cost.

One operator running 1st and 2nd operations
completes 45 Hubs per hour

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ENGINEERING INDEX (Continued)

NICKEL STEEL

Physical Properties

Action of Metallurgical Additions Upon Anomaly of Expansibility of Nickel Steels (Action des additions métallurgiques sur l'anomalie de dilatabilité des aciers au nickel), Ch.-Ed. Guillaume. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 25, June 21, 1920, pp. 1433-1435, 2 figs. Graphs showing variations of coefficient of expansion against deviation in nickel content of invar steel, for four nickel steels, one containing additional small amount of carbon, and others chromium, copper and manganese, respectively; also variation of coefficient of expansion against percentage of third constituent for constant proportion of nickel and iron.

Changes Produced by Heat in Elastic Properties of Nickel Steels (Changement thermique des proprietés élastiques des aciers au nickel), M. P. Chevenard. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 25, June 21, 1920, pp. 1499-1502, 2 figs. Graphs plotted from measurements of modulus of torsion, at various temperatures, of differently treated specimens of steel with 36 per cent nickel.

Expansibility of Nickel Steels (Valeurs des dilatabilités des aciers au nickel types), Ch.-Ed Guillaume. Comptes rendus des Séances de l'Academie des Sciences, vol. 170, no. 26, June 28, 1920, pp. 1554-1557, 2 figs. Graphs giving coefficient of expansion at 20 deg. cent. of nickel steels of different nickel percentages and containing 0.4 per cent manganese and 0.1 carbon per cent simultaneously.

NITROGEN

Fixation

Cyanamide Process Plant at Muscle Shoals, Chester H. Jones. Chem. & Metallurgical Eng., vol. 23, no. 5, Aug. 4, 1920, pp. 182-187, 16 figs. Sketch of U. S. Nitrate plant No. 2 shown by photographs and flow sheets.

NOZZLES

De Laval

The Determination of Temperature of Rapidly Flowing Gases or Vapors by Expansion in a de Laval Nozzle (Ueber die Ermittlung des Temperaturverlaufes von schnellströmenden Gasen oder Dämpfen bei Expansion in einer Laval-Düse), Friedrich Mäller. Zeitschrift für das gesamte Turbinenwesen, vol. 17, nos. 6, 7, 8 and 9, Feb. 29, Mar. 10, 20 and 30, 1920, pp. 61-65, 76-80, 87-90 and 100-106, 26 figs. Results of experiments show agreement with Batho that temperatures of wet vapors flowing in a nozzle are properly measured with thermocouples, and accord with Nusselt that in temperature measurement of dry and superheated steam, the use of thermocouples must be avoided, and contrast of the contradictory results is explained. It is said that a final solution can probably be achieved only with aid of a more precise testing device.

O

OFFICE MANAGEMENT

Stenographic Department

Getting the Office Work Done—II, Wallace Clark. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 116-121, 6 figs. How to organize stenographic department.

OIL ENGINES

Ingersoll-Rand

Many New Ideas in Ingersoll-Rand P-R Oil Engine. Automotive Manufacturer. vol. 62, no. 3, June 1920, pp. 7-12, 6 figs. New type of engine said to possess many novel features and to produce high unit power output and low fuel consumption, as well as remarkably slow speed.

Solid-Injection

The Lincoln Works of Messrs. Ruston and Hornsby, Limited. Eng., vol. 110, no. 2844, July 2. 1920, pp. 4-10, 24 figs, partly on 2 supp. plates. Among principal products manufactured are solid-injection crude-oil engines which are built of single-cylinder type in 11 sizes ranging from 15 b.hp. to 170 b.hp. and double-cylinder type in 5 sizes from 100 b.hp. to 340 b.hp. Engine of latter type developing 260 b.hp. is described and illustrated. (To be continued.)

[See also DIESEL ENGINES; HEAVY-OIL ENGINES; KEROSENE ENGINES.]

OIL FIELDS

British Empire

The Oil Resources of the British Empire, John Cadman. Jl. Royal Soc. of Arts, vol. 68, no. 3532, July 30, 1920, pp. 584-596 and (discussion) pp. 596-600. Statistics of production with comparative analyses of various kinds of oil.

New Mexico

Probable Oil Resources of New Mexico, John K. Knox. Eng. & Min. Jl., vol. 110, no. 2, July 10, 1920, pp. 69-74. Summary of stratigraphic and structural geology of state, with particular reference to possible sources of petroleum; some oil has been discovered, and a few localities are promising. Paper read in more extended form before Am. Assn. Petroleum Geologists.

Persia and Near East

Petroleum in Persia and the Near East, Edmund M. Spieker. Eng. & Min. Jl., vol. 110, no. 7, Aug. 14, 1920, pp. 316-323, 1 fig. Area is said to comprise richest and most extensive oil-bearing region of the world. Geological characteristics, commercial possibilities and potentialities of future development are indicated.

Relationship with Gas Fields

Experimental Studies of Subsurface Relationships in Oil and Gas Fields, R. Van A. Mills. Economic Geology, vol. 15, no. 5, July-Aug. 1920, pp. 398-421, 10 figs. Apparatus and methods developed by writer for laboratory study of subsurface relationships of oil and gas fields.

OIL FUEL

White System

The White Oil-Fuel System. Eng., vol. 10, no. 2844, July 2, 1920. pp. 23-24, 16 figs, partly on 2 supp. plates. Oil is forced into burners at pressure of from 60 to 90 lb. per square inch, and sprayed by mechanical action only. This system has been used in oil-fuel installations recently completed on Cunard liner Aquitania and White Star liner Olympic.

ORES

Density Determination

Density Determination of Semi-Hard Ores, R. H. McHardy. Eng. & Min. Jl., vol. 110, no 2, July 10, 1920, p. 65, 2 figs. Describes modified method of determining density factor devised for purposes of estimating tonnage of iron ore removed from drifts and raises at Harold mine, Hibbing, Minn., and used instead of so-called "oats" method, which is also described.

OVENS

Electrically Heated

Experience with Electric Core Baking, Alan D. Dauch. Elec. World, vol. 76, no 4, July 24, 1920, pp. 168-170, 4 figs. Reduction of baking time, greater uniformity of product, improved washing conditions and decreased labor cost shown in changing from gas to electric ovens.

OXY-ACETYLENE CUTTING

Iron and Steel

Metallography of Iron and Steel as Related to Cutting with Oxygen, F. J. Mapolitan. Metal Trades, vol. 11, no. 8, Aug. 1920, pp. 325-326. Account of experience in cutting iron and steel of different carbon compositions at Eng. & Research Laboratory of Davis-Bournonville Co.

Under Water

Autogenous Cutting Under Water (Autogenschneiden unter Wasser). Autogene Metallbearbeitung, vol. 13, no. 5, Mar. 1, 1920, pp. 54-58, 8 figs. States that the Larsen sheet piling and a described method of cutting under water can be used wherever large cofferdams are required instead of the costly double-wall wooden cofferdams.

OXY-ACETYLENE WELDING

Applications

The Rapid Repair of Machinery Equipment by the Autogenous Cutting and Welding Process (Beschleunigte Ausbesserungen von maschinellen Einrichtungen durch das autogene Schneid- und Schweissverfahren), A. Nolte. Stahl u. Eisen, vol. 40, no. 21, May 27, pp. 713-717, 17 figs. Writer gives examples of practical application of this process in works under his superintendence.

Safety Devices

Safety Devices for Use in Autogenous Metalworking (Sicherungen bei der autogenen Metallbearbeitung), P. Max Grenpe. Der praktische Maschinen-Konstrukteur, vol. 53, nos. 11 and 13, Mar. 8 and Apr. 1. 1920, pp. 45-47 and 52-54, 4 figs. States safety regulations and describes arrangements for prevention of accidents used in the works of German General Elec. Co., including device for preventing standing steel bottles from falling over, carts for transporting them, etc.

P

PACKING HOUSES

Waste Disposal

The Packingtown Waste Problem, Langdon Pearse. Jl. Western Soc. of Engrs., vol. 25, no. 11, July 20, 1920, pp. 365-373. Account of packing-house waste situation in sanitary district of Chicago. Waste amounts to about 75 tons of dry solids a day. Bearing of this load on sewage disposal of Chicago is explained.

PAPER MANUFACTURE

Research

Research Problems of the Pulp and Paper Industry, D. C. Everest. Paper, vol. 26, no. 22, Aug. 4, 1920, pp. 11-14 and p. 30, 2 figs. Survey of work of Forest Products Laboratory.

PAVEMENTS, CONCRETE

Construction

Concrete Pavements and Walks, Tyrrell B. Shnertzer. Nat. Lime Assn., no. 3, 7 pp. 1 fig. Directions for putting in sub-base and for proportioning and mixing concrete base and top course.

PIERS

Staten Island

New Steamship Piers on Staten Island are Too Narrow, John Meigs, William S. Wilgus, Frank G. White, Fay, Spofford & Thorndike, Frederick W. Cowie and George F. Nicholson. Eng. News-Rec., vol. 85, no. 4, July 22, 1920, pp. 160-165. Opinions of leading port and terminal engineers.

PIPE, CAST IRON

Cement Joints for

Cement Joints for Cast Iron Water Pipe, George W. Pracy. Jl. of Am. Water Works Assn., vol. 7, no. 4, July 1920, pp. 436-439. It is pointed out that cement joints increase electric resistance of pipe, a feature of particular importance in larger cities where electrolytic action does considerable damage. Other advantages lead writer to believe cement joint has come to stay.

PIPE LINES

Natural Gas Transportation

Pipe Lines for Transporting Natural Gas, Clifford E. Brock. Mech. Eng., vol. 42, no. 8, Aug. 1920, pp. 445-447, 4 figs. Construction, repair and operation of jointed and welded lines, including particulars regarding couplings used, pipe-laying machines, strength of welded pipe, pressure regulation, etc.

PIPE, STEEL

Spirally Ribbed

The Manufacture of Pipes with Spiral Ribs and of Pipes for Exchange of Heat from Rolled Sections (Herstellung von Rohren mit Spiralförmig verlaufenden Rippen und von Wärmeaustauschrohren aus Walzprofilen). Autogene Metallbearbeitung, vol. 13, nos. 3 and 10, Feb. 1 and May 15, 1920, pp. 33-34 and 107-109, 10 figs. Feb. 1. Describes process in which they are made by winding a special T section around a mandrel and welding together the contiguous spirals. May 15. Describes construction of similar pipes patented by Chief Engineer Wiss of the Griesheim-Electron Chem. Factory.

POLES

Electric Current for Treating

Utilizing Electric Current for Treating of Wooden Poles, F. C. Adsett. Can. Engr., vol. 39, no. 6, Aug. 5, 1920, p. 215. Heating of small wood-preserving plants electrically, instead of by open wood fire, is said to have proven economical both in labor and preservative in experiences at Trenton, Ont. From Bul. of Hydro-Electric Power Commission of Ontario.

POLES, STEEL

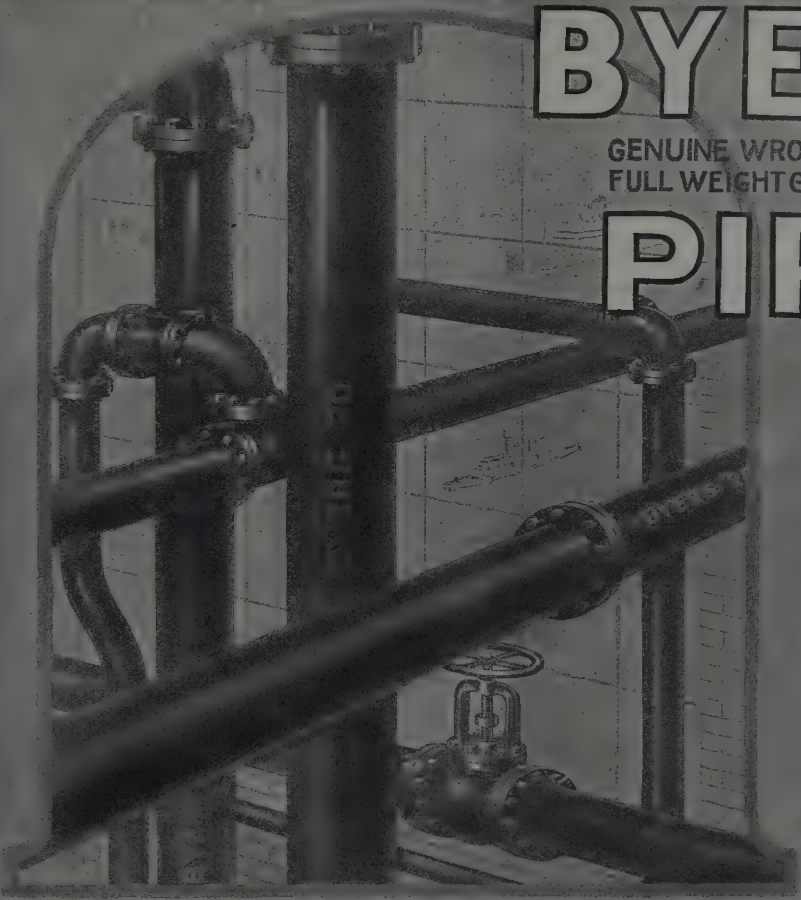
Latticed

The Calculation of Steel Poles (Die Berechnung von Gittermasten), E. Schütz. Der praktische Maschinen-Konstrukteur, vol. 53, nos. 3, 5 and 7, Jan. 22, Feb. 5 and 19, 1920, pp. 23-27, 40-43 and 56-60, 7 figs. Results obtained by calculating the moments of inertia and resistance for standard angle-iron and U-iron sections at different distances apart with and without consideration of influence of the rivet holes, are given in tabular form and values thus obtained are said to effect great saving of time in calculation of latticed steel poles.

PORTS

Facilities for Handling Traffic

Port Facilities, Charles Evan Fowler.



BYERS

GENUINE WROUGHT IRON
FULL WEIGHT GUARANTEED

PIPE

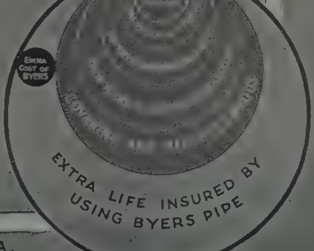
How Big Is the Extra Cost?

"DO you think you are justified in paying $208.00 extra for Byers pipe on this job?" asked the General Manager. "That is 40% more than for other pipe."

"True," retorted the Chief Engineer, "but you will note from this estimate that the total of this pipe contract is $8200.00. If the pipe fails, the whole investment is lost, for your salvage consists of little but a few fittings and valves. So, in getting better pipe, the extra $208.00 is really only a four per cent premium paid to insure a very much longer life of the whole system.

Where corrosion is a factor, Byers pipe of genuine wrought iron, doubles or trebles the *life* of the whole system, yet on an average adds less than five per cent to its *cost*. Study the detailed facts and figures in Byers' latest Bulletin, No. 38—"The Installation Cost of Pipe Systems."

Byers Bulletin No. 38 (illustrated), entitled "The Installation Cost of Pipe," contains cost analyses of a large variety of power and industrial pipe systems, with notes on corrosive conditions, renewal expense and salvage. Send for a copy today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EXTRA LIFE INSURED BY USING BYERS PIPE

A. M. BYERS COMPANY, PITTSBURGH, PA.
ESTABLISHED 1864
NEW YORK BOSTON PHILADELPHIA CLEVELAND CHICAGO DALLAS

Freight Handling & Terminal Eng., vol. 6, no. 7, July 1920, pp. 265-268. Discussion of types of docks and piers and port equipment best suited for rapid handling of traffic. Paper read before Great Lakes-Tidewater Congress.

PRESS WORK

Stamping Electric-Fan Base

Making a Pressed-Steel Base for Electric Fan, H. Jay. Am. Mach., vol. 53, no. 8, Aug. 19, 1920, pp. 361-362, 9 figs. Stamping process for producing base of an electric fan, method being different from that usually employed for making such parts.

PROFIT SHARING

Coöperation and

Coöperation and Profit Sharing. Monthly Labor Rev., vol. 10, no. 6, June 1920, pp. 117-145. Discussion of aims and possibilities of the Consumers' coöperative movement; Russian coöperative movement; progress of coöperation in various countries, including Denmark, Germany, India, Italy, Netherlands, Norway, Roumania and Sweden; profit sharing and labor copartnership in the United Kingdom.

PROPELLERS, SHIP

Four-Blade vs. Three-Blade

Model Experiments for a Double-Screw Tug Boat of 1400 Hp. (Modeleversuche für einen Doppelschrauben-Schlepper von 1400 PSi), K. Schaffran. Schiffbau, vol. 21, no. 31, June 23, 1920, pp. 851-856, 8 figs. Results of tests to determine influence of number of blades on towing efficiency showed efficiency of 4-blade propellers tested to be 4 per cent higher than that of the 3-blade propellers.

Thrust and Efficiency

Calculation of the Thrust and Efficiency of the Screw Propeller (Zur Berechnung des Schubes und Wirkungsgrades von hinter dem Schiff arbeitenden Schrauben), H. Wittmaack. Schiffbau, vol. 21, nos. 28 and 29, June 2 and 9, 1920, pp. 763-767 and 794-800, 3 figs. Writer states that through mathematical investigations he has arrived at a new assumption of the working method of these screws which deviates from method widely accepted. Both methods are described.

PULLEYS

Compressed-Spruce

An Investigation of Compressed-Spruce Pulleys, George S. Wilson. Mech. Eng., vol. 42, no. 8, Aug. 1920, pp. 451-452, 4 figs. Comparative tests of cast-iron, steel, wood, paper, and compressed-spruce pulleys. Latter pulleys were found to be as serviceable as any of ordinary commercial types.

PULVERIZED COAL

Boiler Firing

Powdered Coal as a Fuel for Boiler, Edward R. Welles and W. H. Jacobi. Stevens Indicator, vol. 37, no. 2, April 1920, pp. 97-125, 10 figs. Advantages of pulverized coal over lump coal are enumerated and comparative cost figures of burning coal in these two forms are presented. Burners and furnaces for pulverized coal are described.

Combustion

Science of Powdered Fuel Combustion, Joseph F. Shadgen. Iron Age, vol. 106, no. 8, Aug. 19, 1920, pp. 457-461. Thermic fundamentals. Effects of various air quantities on temperature and gases produced. Ash problem. Burner essentials.

Railway Power Plants

Pulverized Fuel for Peak-Load Service in Railway Power Plants, O. M. Rau. Power, vol. 52, no. 4, July 27, 1920, pp. 140-141. Experience of Philadelphia Rapid Transit Co.

PUMPING STATIONS

Construction

Difficulties in Building Pumping Station, James B. Wilson. Fire & Water Eng., vol. 68, no. 6, Aug. 11, 1920, pp. 291-293, 2 figs. Special requirements which had to be met in design of pumping station because foundation had to be laid without rock basis.

PUMPS

Vacuum

The Production and Measurement of High Vacua. Part II. Methods for the Production of Low Pressures, Saul Dushman. Gen. Elec. Rev., vol. 23, no. 7, July 1920, pp. 605-614, 17 figs. Types of pumps that have been developed for production of high vacua.

R

RADIATION

Cylindrical Wall

On Radiation from a Cylindrical Wall, A. C. Bartlett. Lond., Edinburgh, and Dublin Philosophical Mag. & Jl. of Sci., vol. 40, no. 325, July 1920, pp. 111-113. In paper under above heading in same journal (Mar. 1920), an expression is obtained by a laborious process for amount of heat radiated from inner walls of a vertical cylinder on to a horizontal coaxial disk; writer claims it is possible to deduce result by method described which is claimed to be not only much simpler but more generally applicable.

RADIO FREQUENCY

Measurements

Note on Radio Frequency Measurements, Carl Englund. Proc. Inst. of Radio Engrs., vol. 8, no. 4, Aug. 1920, pp. 326-333, 4 figs. After discussing need for radio frequency bridge on grounds of general utility, bridge method is critically compared with indicating, null, and potentiometer meethods. Certain precautions in shielding and coil construction are considered and specific form of bridge used by writer is describbed.

RADIOTELEGRAPHY

Amplifiers

On the Input Impedance of the Thermionic Amplifier, Stuart Ballantine. Physical Rev., vol. 15, no. 5, sec. series, May 1920, pp. 409-420, 10 figs. Phenomena described are investigated analytically and expressions are developed for values of effective capacity and conductance for various loading conditions. Physical significance of equations is depicted by series of curves, plotted for various load configurations of analysis. Equations are developed for choosing proper inductances for regenerative receiving circuits, and desirability of so designing tubes as to avoid excessive grid-plate capacity is emphasized.

Contact Detectors

An Oscillation Method for Testing the Inertia of Contact Detectors (Eine Schwebungsmethode zur Prüfung der Trägheit von Kontaktdetektoren), Robert Ettenreich. Physikalische Zeitschrift, vol. 21, no. 8, Apr. 15, 1920, pp. 208-214, 12 figs. For the determination of the critical frequency at which a detector fails because of its electric inertia, an electric resonance method based on the interference principle is developed, whereby the detector lies in an aperiodic circuit which transmits the oscillations of two audion generators to one measuring circuit.

Distress-Calling Device

The New Marconi Distress Calling Device. Wireless Age, vol. 10, no. 7, July 1920, pp. 18-19, 6 figs. Description of device by means of which bell at a considerable distance can be rung by wireless and act as a signal of distress.

Position Finding in Aeroplanes

Wireless Telegraphy for Position-Finding in Aeroplanees (Funkentelegraphische Ortsbestimmung für Luftfahrzeuge), Max Dieckmann. Luftfahrt, vol. 24, no. 4, Apr. 1, 1920, pp. 57-59, 12 figs. Account of observations made in Zeppelin dirigibles in the interest of direction-finding with frame and loop antennae, but without high-frequency amplifiers. Describes type of hanging antenna which, as direction antenna, has advantage of not operating bilaterally and of recording measurements definitely within 360 deg.

Received Currents, Measurement of

The Measurement of Received Radio Currents with the Electrometer, E. O. Hulbert and G. Breit. Physical Rev., vol. 15, no. 5, sec. series, May 1920, pp. 405-408, 2 figs. Describes new method for accurate measurement of received currents by means of the quadrant electrometer connected in plate circuit of an electron tube which is used either singly or as detector tube of a multistage amplifier. In order to employ such an arrangement to measure signal intensity, relation between electrometer deflection and effective input voltage must be known, and a condenser potentiometer for such calibration has been devised.

Station

New York Radio Central Station. Telegraph and Telephone Age, no. 15, Aug. 16, 1920, pp. 421-423, 1 fig. Description of superpowered radio station to be erected by Radio Corporation of America.

Trans-Oceanic

Measurement of the Electromagnetic Field of Waves Received During Trans-Oceanic Radio Transmission, Giancarlo Vallauri. Proc. Inst. of Radio Engrs., vol. 8, no. 4, Aug. 1920, pp. 286-296 and (discussion) pp. 297-298, 2 figs. Experiments are described on determination of electric and magnetic field intensities of waves received at Leghorn, Italy, from Annapolis, Md., transmitting station. Pair of large loops, respectively practically parallel and perpendicular to incoming wave, are used. Incoming signals are received by heterodyne oscillator and amplified. Substitution method is used for measurements, whereby incoming signal is compared to artificial signal produced in non-receptive loop by local oscillator.

Trans-Oceanic Radio Communication, Ernest F. W. Alexanderson. Proc. Inst. of Radio Engrs., vol. 8, no. 4, Aug. 1920, pp. 263-285, 15 figs. Possible limitation in number of long-distance radio sections simultaneously in operation is considered. It is shown how high-speed transmission, improved directional selectivity, and better frequency selectivity would greatly increase number of feasible coëxistent stations. Utilization of wave-length band as result of high-speed transmission is discussed in connection with frequency selectivity. 200-kw. alternator station at New Brunswick is described, special mention being made of constant speed regulation system for induction motor drive, functioning of magnetic amplifier, and operation of multiple antenna.

Wave Meters

Wave Meters with Capacity-Measuring Bridges (Wellenmesser mit Kapazitätsmessbrücke), F. Kock. Physikalische Zeitschrift, vol. 21, no. 8, Apr. 15, 1920, pp. 214-216, 4 figs. Describes apparatus which was used by author for measurements of wireless telegraphy systems and field receivers with good success during the war.

[See also VACUUM TUBES.]

RADIUM

Relative Activity

The Relative Activity of Radium and the Uranium with which it is in Radioactive Equilibrium, J. H. L. Johnstone and B. B. Boltwood, Lond., Edinburgh, and Dublin Philosophical Mag., & Jl. of Sci., vol. 40, no. 235, July 1920, pp. 50-67, 2 figs. Results obtained from redetermination indicate that if activity of uranium is taken as unity the activity of radium is equal to approximately 0.49. Total activity of uranium mixed with equilibrium quantities of its disintegration products has been compared with activity of uranium alone, and former has been found to be 4.73 times latter.

RAILS

Failures

Studying Failure of Steel Rails, James E. Howard. Iron Trade Rev., vol. 67, no. 1, July 1, 1920, pp. 25-27, 6 figs. Shattered zones were found along middle of head and at junction of web and base and are thought to form after last passing of rolls. Cold-rolling action of wheels. Paper read before Am. Soc. for Testing Materials.

Rolling of

Pipeless Product from Annular Blooms, C. A. Witter. Blast Furnace and Steel Plant, vol. 8, no. 7, July 1920, pp. 414-416, 4 figs. Proposed method of rolling rails, blooms, billets, and bars free from piping and segregation. Solution of railroad's and rail manufacturer's problems.

RAILWAY CONSTRUCTION

Virtual Lengths

Virtual Lengths for Railroads (Die virtuellen Längen für Eisenbahnen), Hans Weber. Verkehrstecknik, vol. 37, nos. 4 and 6, Feb. 5 and 25, 1920, pp. 45-47 and 82-84, 2 figs. It is pointed out that the formulæ for calculation of virtual lengths in their present form are too complicated for practical use, and writer therefore seeks, by making permissible reductions, to simplify them to extent that they can be readily employed by every engineer and, as result of their symmetrical development, can be readily remembered.

RAILWAY ELECTRIFICATION

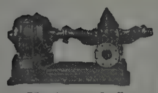
Belgium

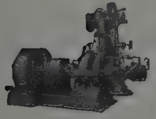
The Electrification of the Belgian State Railways. Ry. Gaz., vol. 33, no. 2, July 9, 1920, pp. 55-56. Outline of scheme. Proposed routes and anticipated operating advantages and estimated savings.

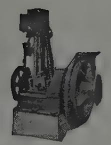
Switzerland

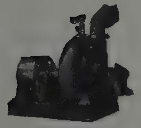
Swiss State Railways Electrification. Elec. Ry. & Tramway Jl., vol. 42, no. 1029, June 11, 1920, pp. 225-228, 9 figs. St. Gothard section partly completed. Details of the Ritom power station utilizing Foss torrent from Ritom lake, provision being made for taking water at 30 m. below actual surface level. Electric locomotives have continuous power of 2400 hp., and total weight for direct trains of 107.6 tons and for goods trains of 121 tons.

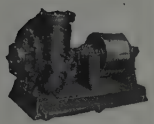
On the Job with MORRIS

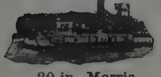

Horizontal Split Double Suction Pump.


Centrifugal Fire Underwriters' Pump.


Standard Side Suction Steam Pump.


Standard Hydraulic Dredging and Sand Pump.


Solid Lined Dredging Pump.


20-in. Morris Hydraulic Dredge.

Morris Underwriters' Fire Pumps

This isn't the first time we have advertised these pumps as installed in the City of Stratford, Ontario. But we wish to quote from a recent letter regarding them—as follows:

"These pumps (driven by Van Blerk gas engines) are used for emergency purposes, Niagara Electric Power being our original source. They have been subjected to considerable work, especially during changes of the plant—they have given no trouble and the upkeep has been nil" In other words Stratford depends on these Morris Centrifugals for emergency fire fighting and the pumps have made good. It will pay many plants to install Morris Underwriters Pumps directly connected both to electric motor and gas engine. It saves coal and insures service at a moment's notice. Each pump has full Underwriters' fittings.

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Centrifugal
Pumps, Steam
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BRANCH OFFICES IN PRINCIPAL CITIES

ENGINEERING INDEX (Continued)

RAILWAY OPERATION

Freight-Train Load

Economics of the Freight Train Load, Wm. J. Cunningham. Ry. Rev., vol. 67, no 2, July 10, 1920, pp. 42-45. Author develops equations for determining the theoretically correct loading of freight locomotives and shows wherein these determinations should be deviated from in order to meet certain practical consideration. The ton-miles-per-freight train-hour basis of measuring and comparing output is advocated. Paper read before New England RR. Clum.

Passenger Traffic

The Regulation of High-Density Passenger Traffic. Ry. Gaz., vol. 33, no. 1, July 4, 1920, pp. 9-24, 19 figs. and map on supp. page. Method of Lancashire & Yorkshire Ry. Co. for regulating heavy seasonal passenger traffic to Lancashire Coast resorts by scientific scheme of advance booking of travel. Scheme, it is explained, insures comfort of passengers, facilitates traffic arrangements, and effects economies in engine power, trainmen's wages and station staff.

RAILWAY SIGNALING

Electrically Lighted Signals

The Electric Lighting of Railroad Signals, L. C. Porter and F. S. Stallknecht. Illuminating Eng. Soc., Trans., vol. 15, no. 4, June 10, 1920, pp. 223-242, 24 figs. Advantages of electric lighting over oil lamps, factors to be considered in design of electric lamps, conversion of oil lamps into electric lamps.

Non-Automatic Blocks

Non-Automatic Blocks and Accident Records, W. P. Borland. Ry. Signal Engr., vol. 13, no. 8, Aug. 1920, pp. 306-309. Study of five-year record of collisions.

Time vs. Space Intervals

The Use of Signals for Better Train Operation—I, Henry M. Sperry. Ry. Signal Engr., vol. 13, no. 7, July 1920, pp. 270-275, 5 figs. Comparison of time-interval, and space interval methods leads to the conclusion that delays and hazards are reduced to the minimum by latter and that maximum track capacity is also possible under this method. (To be continued.)

RAILWAY TRACK

Construction

A Short Cut in Estimating Track Materials, H. M. Booth, Jr., Ry. Maintenance Engr., vol. 16, no. 8, Aug. 1920, pp. 314-315, 1 fig. Chart for estimating amount of materials that enter into construction of industrial track and sidings.

Switches

Switches with Curved Crossings (Weichen mit gekrummten Herzstücken), H. Schwartz. Zentralblatt der Bauverwaltung, vol. 40, no. 19, Mar. 6, 1920, pp. 119-123, 19 figs. Describes new switches, some of advantages of which are said to be: With 190-m. radius switch, a 1:6 set of points can be obtained without changing the tongue arrangement and the 1:9 radius of switch; the 1:7 switch can be dispensed with; number of required switches and accessory parts is diminished, etc.

Tie-Plate Corrosion

Copper Reduces Corrosion in Tie Plates. Ry. Maintenance Engr., vol. 16, no. 7, July 1920, pp. 255-256, 2 figs. New York Central experiments showed that introduction of small percentage in steel made marked difference in corrosion of tie plates.

RAILWAYS

Czecho-Slovakia

The Railways of Czecho-Slovakia, Vladimir A. Geringer. Ry. Rev., vol. 67, no. 2, July 10, 1920, pp. 48-51. Data abstracted from report by U. S. Trade Commissioner at Prague, embodying official statement by Dr. Franke, Minister of Railways of Czecho-Slovak Republic.

RECTIFIERS

Crystal-Detector

The Action of Crystal Detector Rectifiers (Die Gleichrichterwirkung von Kristalldetektoren), M. J. Huizinga. Physikalische Zeitschrift, vol. 21, no. 4, Feb. 15, 1920, pp. 91-97, 3 figs. Results of experiments carried out at Physical Inst. of Groningen University are said to show that in iron pyrite detectors as well as in molybdenum glance detectors an electrolytic decomposition is apparent. Comparison of direct current characteristics of these detectors with those of other crystal detectors and of electrolytic cells demonstrated that action of rectifier in the case of all the tested detectors was caused by electrolytic polarization within an adhering moisture and gas layer.

New Type

A New Rectifier of Alternating Current for Charging Storage Batteries (Un nouveau redresseur de courant alternatif pour charge d'accumulateurs), J. Quinet. Electricien, vol. 35, no. 1254, June 15, 1920, pp. 250-252, 4 figs. Mechanical apparatus operating on principle of Soulier type, but utilizing both alterations of current instead of only one. Soulier's rectifier is of mechanical type and rectification is effected by oscillations of metallic plate which by contact allows passage of current in only one direction.

REFRACTORIES

Chemical Uses

Refractory Materials for Chemical Purposes—II, A. B. Searle. Chem. Age (Lond.), vol. 3, no. 59, July 31, 1920, pp. 123-124. Effect of various chemical substances on fireclays is pointed out and method of preventing corrosion is indicated.

Reversible Expansion of

The Reversible Expansion of Refractory Materials, H. J. Hodsman and J. W. Cobb. Gas. Jl., vol. 151, no. 2985, July 28, 1920, pp. 184-187, 6 figs. Results of experimental research. States that calcined alumina, magnesia brick, carborundum, calcined kaolin and hard calcined ball-clay expand regularly up to 1000 per cent. Most refractories expand roughly ½ per cent up to 100 deg., but magnesia brick more than twice this amount. Paper read before Soc. of Glass Technology.

Specific Heats

The Specific Heats of Refractory Materials at High Temperatures, L. Bradshaw and W. Emery. Gas World, vol. 72, no. 1872, June 5, 1920, pp. 22-24, Coking Section, 2 figs. Measurements of specific heats of silica, fireclay and zirconia.

REFRIGERATING MACHINES

Tests

Experiments with a Large Ammonia Refrigerating Machine (Versuche an einer grossen Ammoniak-Kältemaschine), Martin Krause. Zeitschrift für die gesamte Kälte-Industrie, vol. 27, no. 4, Apr. 1920, pp. 35-38, 1 fig. Results of various experiments are given in tabular form. (Concluded.)

REFRIGERATING PLANTS

Troubles

Trouble-Hunting in Refrigerating Plants, J. C. Moran. Power, vol. 52, nos. 3 and 5, July 20 and Aug. 3, 1920, pp. 87-89, 2 figs., and 168-170, 2 figs. July 20: One installation of two 100-ton single-acting twin-cylinder machines, two double-pipe condensers, and direct-expansion coils was giving one-half of normal capacity only. How plant was brought back to normal production without introducing new machinery is related. Aug. 3: How a faulty gate valve in brine-circulating system caused freeze-up of nearly the entire system.

Union Stock Yards, Chicago

Large Freezer Plant at Union Stock Yards, Chicago. Ice and Refrigeration, vol. 59, no. 2, Aug. 1920, pp. 37-40, 5 figs. Ten-story building erected at cost of about $2,000,000 with capacity for freezing approximately 50,000,000 lb. of meat and meat products.

RESEARCH

Alloys

Thermo-Electromotive Force and Alloy Research, John L. Haughton. Eng., vol. 109, no. 2841, June 11, 1920, pp. 803-807, 8 figs. Study of thermal electromotive force as aid to investigation on constitution of alloy systems, with appendix on Peltier and other effects. Paper read before Inst. of Metals.

Government-Conducted

The Economic Importance of the Scientific Work of the Government, Edward B. Rosa. Sci. Monthly, vol. 11, no. 1, July 1920, pp. 5-24, 6 figs. Address before Washington Acad. of Sci. (To be concluded.)

Observations, Adjustment of

The Adjustment of Observations, R. Meldrum Stewart. London, Edinburgh & Dublin Philosophical Mag. & Jl. of Science, vol. 40, no 236, Aug. 1920, pp. 217-227. Criticism of method of deduction on observations offered as substitute for method of least squares by Dr. Norman Campbell in Philosophical Mag., Feb. 1920, p. 177.

Organization of

The Organization of Research, James R. Angell. Sci. Monthly, vol. 11, no. 1, July 1920, pp. 25-42. Notes on conception and distribution of research functions, personnel, organization and coöperation, and organization of Nat. Research Council for mobilization of the scientific resources of the country to permit their most effective use continuously in times of peace as well as war.

Place in Industry

The Art of Systematic Inquiry (Research), Its Place in Industry, H. E. Armstrong, Eng., vol. 109, no. 2839, May 28, 1920, pp. 735-737. Lecture delivered before Ceramic Soc.

[See also PAPER MANUFACTURE.]

RIVERS

Levee Construction, Dayton, O.

High-Speed Block-Laying on Miami River Levees. Eng. News-Rec., vol. 85, no. 6, Aug. 5, 1920, pp. 248-249, 1 fig. Flexible concrete mattress construction by stringing precast concrete blocks on steel cable being done in improving channel of Miami River at Dayton, Ohio.

Regulation

Improvement Work on River Murray in South Australia, Robert C. Cutting. Eng. News-Rec., vol. 85, no. 6, Aug. 5, 1920, pp. 244-246, 6 figs. Regulation of longest river on island for navigation by locks and dams.

ROAD CONSTRUCTION

Winter Construction

Winter Road Work in the Dakotas, Minnesota, and Wisconsin a Success, E. G. Edwards. Public Roads, vol. 3, no. 25, May 1920, pp. 7-10, 5 figs. Advantages claimed for building roads in winter are (1) greater accessibility of pits, (2) larger number of teams available and (3) lengthening of construction period.

ROAD MATERIALS

Standard Specifications

Proposed Standard Specifications for Road Building Materials. Rock Products, vol. 23, no. 15, July 17, 1920, pp. 31-33. Proposed methods for testing quantity of clay and silt in sand and gravel; standard sizes of crushed stone, sand and gravel; methods for sampling crushed stone, sand, gravel and slag; and specifications for crusher-run slag for macadam roads. Specifications proposed at convention of the Am. Soc. for Testing Materials.

Testing

Testing of Roads and Road Materials. Quarry, vol. 25, no. 282, Aug. 1920, pp. 213-215, 4 figs. Procedure in laboratories of Road Testing Dept. at Nat. Physical Laboratory, Teddington, England.

ROADS

Surfacing

Semi-Portable Oil Heating Plant for Surfacing Roads. Eng., News-Rec., vol. 85, no. 6, Aug. 5, 1920, pp. 250-251. Scheme devised by California Highway Commission.

ROADS, GRAVEL

New Hampshire

The Construction of Crushed Gravel Roads in New Hampshire, Frederic E. Everett. Municipal and County Eng., vol. 59, no. 1, July 1920, pp. 5-6. It requires approximately 145 cu. yd. of covering per mile of 16-ft. road to make two applications. There are about 100 miles of crushed gravel road in N. H., some sections of which have been laid as long as 15 yr.

ROADS, MACADAM

Bituminous Surfaced

Bituminous Surface Treated Macadam and Gravel Roads, J. F. Witt. Public Roads, vol. 3, no. 25, May 1920, pp. 3-6, 2 figs. It is claimed that water-bound macadam has been a failure in United States. Practice of writer of treating water-bound macadam with bituminous material is described.

ROCK

Deval Test

A Study of the Standard Deval Test for Rock. Eng. & Contracting, vol. 54, no. 5, Aug. 4, 1920, pp. 113-114, 1 fig. Experiments made to determine how variations in results of tests due to laboratory manipulation might be reduced, and comparative range in values obtained with and without "dust cushion." Paper read before Am. Soc. for Testing Matls.

ROCK CRUSHING

Progress Since 1910

Progress in the Fine Crushing of Hard Material (Neuerungen der Hartzerkleinerung), Carl Naske. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 26, June 26, 1920, pp. 469-475, 30 figs. Account of developments

R
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R-P Oil Circulating and Filtering Systems collect all the oil after it is used on the bearings, pump it to a filter where all dirt, grit, and water are removed and redistribute it to the bearings again—all automatically.

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Capacity 50-300 gallons per hour.
Note extreme simplicity.

ENGINEERING INDEX (Continued)

during last ten years, with description of simple toggle lever, pendulum roll and gyratory crushers; crushing and grinding in one machine and one operation; machines with separate screening of material to be ground, improvements of Griffin mills; screenless ball mills; combination of ball and tube mills, etc.

ROCK DRILLS

Drill Steel

Handling and Treatment of Rock-Drill Steel at Copper Range Mines, H. T. Mercer and A. C. Paulson. Min. & Metallurgy, no. 164, Aug. 1920, pp. 20-21, 1 fig. Reports of each drill machine are made daily by shop and mine, and tables compiled from these reports show footage drilled, steel broken, drills received and sent out of shop, drills sharpened and bits cut off. Dimensions of drill adopted are given and reasons for their adoption explained. (Abstract.)

ROLLING MILLS

Deformation Work in Rolling

The Numerical Determination of the Deformation Work in Rolling, Forging, etc. (Zur rechnerischen Ermittlung der reinen Umformungsarbeit beim Walzen. Schmieden usw.). H. Preussler. Stahl u. Eisen, vol. 40, no. 19, May 13, 1920, pp. 641-649, 7 figs. Derives expression, based on mathematical-mechanical principle for theoretical minimum power required for deformation of a plastic material, which covers every change in form with regard to stretching, expanding and shaping.

Design

Design of Experimental Rolling Mills—II and III, W. B. Skinkle. Blast Furnace and Steel Plant, vol. 8, nos. 7 and 8, July and Aug. 1920, pp. 404-407 and 454-457, 16 figs. Details of design of experimental mill of the Bureau of Rolling Mill Research. General features of different types of mills when they are assembled.

Electrically-Driven

Columbia Steel Company's New Plant. Blast Furnace and Steel Plant, vol. 8, no. 7, July 1920, pp. 401-403, 4 figs. Description of electrically driven merchant mills for production of bars and shapes.

Power Drives for Rolling Mills, W. O. Rogers. Power, vol. 52, nos. 1, 3 and 5, July 6, 20 and Aug. 3, 1920, pp. 9-12, 90-93 and 171-176, 28 figs. Several types of shears are illustrated; plate and job mills, structural, sheet and tin-plate mills, also wire-rod mills are briefly described. Experience with induction motors driving plate mill. Direct-current reversible motors of 5000 to 15,000-hp. capacity used to run reversing blooming mills.

Hoop-Iron Rolling

The Rolling of Hoop Iron (Ueber Bandeisenwalzung), Anton Schöpf. Stahl u. Eisen, vol. 40, no. 19, May 13, 1920, pp. 649-651, 4 figs. Recommends for obtaining improvement in hoop-iron rolling for the last passes continuous rolling with small-diameter rolls and low pressures.

Plate, Canada

First Plate Mill Built in Canada. Iron Age, vol. 106, no. 5, July 29, 1920, pp. 259-262, 5 figs. Plant built by Dominion Iron & Steel Co. at cost of $5,000,000. Mill is of Lauth type, consists of one stand of rolls served by tilting tables, and is driven by 4000-hp. motor through set of cut herringbone pinions.

Plate, Universal

A New Universal Plate Mill. Iron Age, vol. 106, no. 5, July 29, 1920, p. 265, 1 fig. Mill is said to be capable of rolling plates from minimum width of 6 in. to maximum of 40 in.

Power Requirements

Power Requirements of Rolling Mills, Arthur du Pasquier. Trans. of South African Inst. of Elec. Engrs., vol. 11, part 6, June 1920, pp. 104-115, 8 figs. Method for calculating power requirements of rolling mills is suggested and its application exemplified.

Water-Cooled Floors

Design and Use of Water Cooled Floors, W. H. Melaney. Blast Furnace and Steel Plant, vol. 8, no. 7, July 1920, pp. 399-400. Discussion showing general construction and design of these floors as well as their intrnisic value to sheet and tin mills from both labor and production standpoint.

ROPE DRIVE

Multiple-Pulley

Single-Rope Multiple-Pulley Drive (Ueber Mehrscheibenantriebe mit Umschlingung durch dasselbe Seil), Otto Ohnesorge. Fördertechnik u. Frachtverkehr, vol. 13, nos. 5 and 6, Mar. 5 and 19, 1920, pp. 52-54 and 62-65, 7 figs. Points to differences between single-pulley drive and rigid two-pulley drive, and explains peculiarities of two-pulley drive with tension equalization, especially in regard to wear and tear, efficiency and the mechanical law involved.

RUBBER

American Cactus Gum

Experiments with a New Cactus Rubber, Emmet S. Long. India Rubber World, vol. 62, no. 5, Aug. 1, 1920, pp. 709-710, 1 fig. Developments in rubber industry in America predicted as a result of experiments with gum extracted from American cactus.

Cold Vulcanization

The Cold Vulcanisation of Rubber. Chem. Age (Lond.), vol. 3, no. 55, July 3, 1920, pp. 4-5. Account of new Peachey process with appendix giving opinions of H. P. Stevens and Frederick Kaye. Outstanding advantages are said to be: Elimination of cost of steam through cold vulcanization; process occupies about one quarter of time needed by Goodyear process; agents employed—sulphur dioxide and hydrogen sulphide—are available in almost unlimited quantities and at very low cost; dipped goods can be rapidly and effectively cured by new process, etc.

Permeability to Gases

Permeability of Rubber to Gases—I and II, Junius D. Edwards and S. F. Pickering. Chem. & Met. Eng., vol. 23, nos. 1 and 2, July 7 and 14, 1920, pp. 17-21 and 71-75, 7 figs. Nature of permeability and methods and apparatus for its determination described; effect of factors—characteristics of rubbers used, pressure differences, sheet thicknesses, time and temperature. Relative permeabilities of various gases and vapors; factors summarized and data tabulated. Condensation of report to be issued by U. S. Bur. of Standards.

S

SAND

Screening and Washing

The Design of Sand and Gravel Screening and Washing Plants—VI, Frank M. Welch. Rock Products, vol. 23, no. 17, Aug. 14, 1920, pp. 21-25, 10 figs. Considerations regarding loading, type of building and kind of power to use. Concluding article of series of six.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT; TAYLOR SYSTEM.

SEAPLANES

Berthing of

The Berthing of Giant Seaplanes (Die Bergung von See-Grossflugzeugen), Fritz Hammer, Verkehrstechnik, vol. 37, no. 8, Mar., 1920, pp. 109-110, 3 figs. Description of a large hangar which serves as a harbor for hydroplanes, erected on a pile foundation in the water in immediate vicinity of coast; and of a raft floating about a stationary point, measurements of which conform with those of door opening, and by means of which it is possible to bring machine in under all weather conditions.

Floats for

Strength Tests of a Wooden and a Duralumin Float (Festigkeitsprüfungen eines Holz- und eines Duralschwimmers), H. Lewe. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 3, Feb 14, 1920, pp. 37-40, 9 figs. Results of experiments are said to show that both wooden and duralumin floats are constructed according to principles that do not always coincide with static requirements. From standpoint of seaworthiness, only the duralumin float is regarded as sufficiently strong.

SELENIUM

Vapor-Pressure Curves

The Vapor Pressure Curves of Solid and Liquid Selenium near the Melting Point. L. E. Dodd. Jl. Am. Chem. Soc., vol. 42, no. 8. Aug. 1920, pp. 1579-1594, 3 figs. By method of molecular flow, data for sublimation curve for selenium crystals of hexagonal system were obtained over approximate temperature range from 190 to 215 deg. cent. By same method data for vaporization curve for liquefied vitreous, amorphous selenium were obtained over approximate temperature range from 220 to 215 deg. cent.

SEWAGE DISPOSAL

Schrank Settling Tank

Purification of Sewage and the Disposal and Utilization of Precipitated Sludge with Special Reference to the Shrank Settling Tank (Einiges über die Klärung von Abwässern, sowie die Beseitigung und Verwertung des ausfallenden Schlammes, unter besonderer Würdigung der Schrankschen Klärbrunnen), Friedrich Schrank. Gesundheits-Ingenieur, vol. 43, no. 17, Apr. 24, 1920, pp. 196-201, 9 figs. Details of combined precipitation and putrefaction basin which is said to separate putrefying sludge in continuous operation entirely automatically and in such a manner that the actual purification process is insured against disagreeable disturbances through putrefaction or fermentation.

[See also PACKING HOUSES.]

SEWERS

Concrete, Cost of

Sewer Cost Lowered by Increasing Concrete Yardage in Section, John P. Wentworth. Eng. News-Rec., vol. 85, no. 4, July 22, 1920, pp. 148-149, 2 figs. Simplification of form work said to have cut contractor's bid $2 per linear foot and to have saved $1000.

SHIP CONSTRUCTION

Hull Testing

Testing of Hull Structure of Ships—III, F. K. Ruprecht. Int. Marine Eng., vol. 25, no. 8, Aug. 1920, pp. 652-656. Rules and methods for testing chain lockers, shaft tunnels, decks and deck erections, cargo oil compartments and cofferdams.

SHIP DESIGN

Hull Weights, Estimation of

Method of Estimating Steel Hull Weights, G. F. S. Mann. Int. Marine Eng., vol. 25, no. 8, Aug. 1920, pp. 651-652. How curves from weight of ships already built may be expanded and curves plotted for various divisions of hull steel.

SHIPBUILDING

China

Shipbuilding in China. Eng. & Indus. Management, vol. 4, no. 5, July 29, 1920, pp. 136-139, 7 figs. Launching of S.S. Mandarin at Shanghai. Dimensions: Length overall, 445 ft.; length between perpendiculars, 430 ft.; beam, 55 ft.; moulded depth, 38 ft.; mean draft, 28 feet; displacement, 14,750 tons; deadweight carrying capacity, 10,000 tons; i.hp., 3000.

SHIPS

Cargo

The Functions of the Merchant Ship, Norman Hill, Eng., vol. 110, no. 2845, July 9, 1920, pp. 59-60. Economical design of cargo ships. Paper read before Instn. Naval Architects.

War Experience with Merchant Ships, J. J. Welch. Eng., vol. 110, no. 2845, July 9, 1920, pp. 37-41, 2 figs. Some features in design and construction of mercantile vessels considered in light of recent war experience. Comments on answers received to questionnaire sent out by Board of Trade to elicit information relating to the circumstances attending mining or torpedoing of mercantile vessels. Paper read before Instn. Naval Architects.

Coal Carrier

Collier of 1300 Tons D.W. on 13 ft. 9 in. Draught. Shipbuilding & Shipping Rec., vol. 16, no. 6, Aug. 5, 1920, pp. 176-179, 5 figs. Dimensions: Length between perpendiculars, 217 ft.; breadth, 32 ft.; depth moulded, 15 ft. 6 in.; capacity of holds, 61,000 cu. ft.; bunker capacity, 80 tons. Built by S. P. Austin & Son, Ltd., Sunderland.

Gunboats, Conversion to Cargo

The Conversion of Gunboats to Cargo Vessels. Eng., vol. 110, no. 2845, July 9, 1920, pp. 46-47 and p. 50, 8 figs. Conversion involved lengthening hull from 170 ft. to 213 ft. Deadweight capacity of converted ship about 1000 tons.

Passenger

Geared Turbine Passenger Steamer Antwerp, Frederick C. Coleman, Int. Marine Eng., vol. 25, no. 8, Aug. 1920, pp. 625-630, 11 figs., 2 on supp. plates. First of three new steamships for Harwich-Antwerp service of Great Eastern Ry. of England.

Subdivision of Passenger Vessels, George Webster. Eng. vol. 110, no. 2846, July 16, 1920, pp. 94-98, 6 figs. Simplification of method for obtaining flooding curve for ship, proposed by Bulkhead Committee and adopted by British Board of Trade. Paper read before Instn. Naval Architects.

Plating, Effects of Holes, Cracks, Etc.

The Effects of Holes, Cracks and Other Discontinuities in Ships' Plating, E. G. Coker and A. L. Kimball, Jr. Eng., vol. 109, no. 2842, June 18, 1920, pp. 840-842, 17 figs. A crack is considered as limiting case of an ellipse in which minor axis is vanishingly small. It is stated that a crack inclined to direction of stress produces great concentra-

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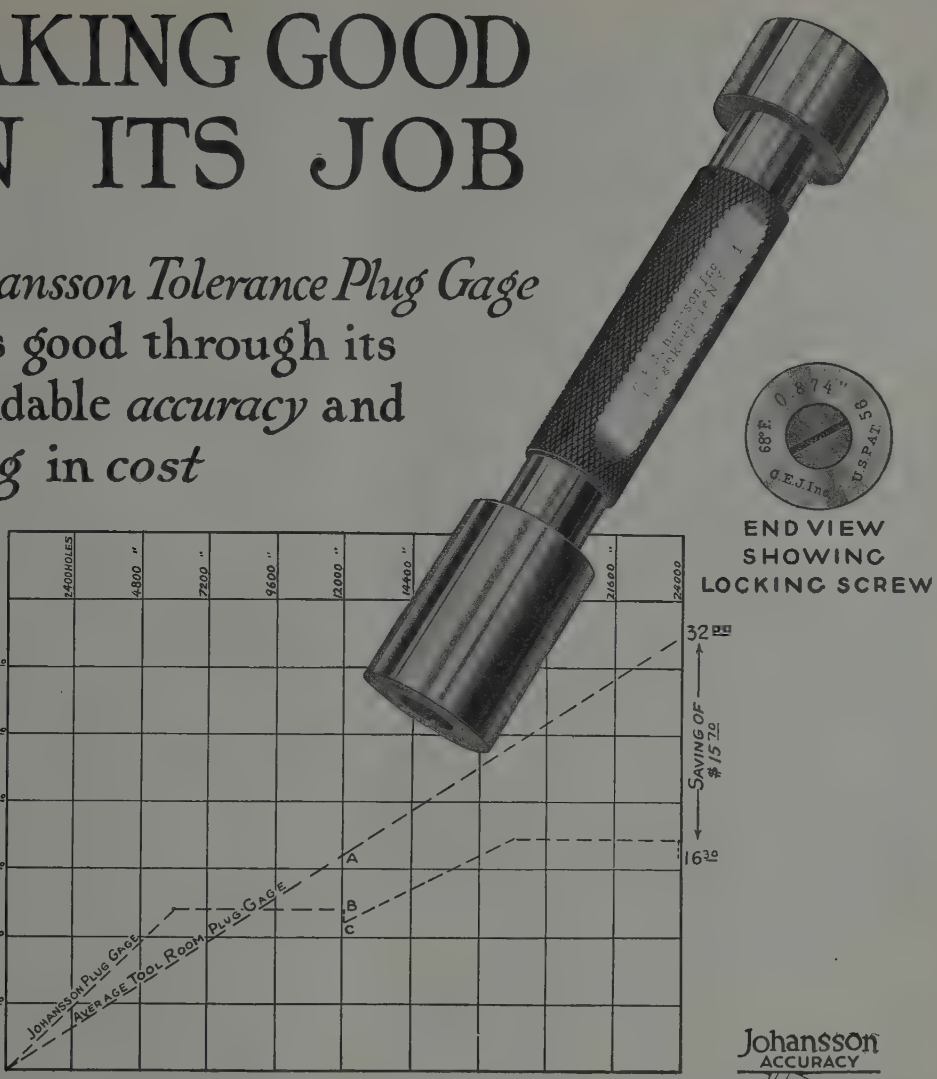

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ENGINEERING INDEX (Continued)

tion which approaches an infinite value. A practical way of reducing stress intensity, it is claimed, is to drill out ends of crack and experiments are described to show what effect this produces and also change in stress produced by forming elliptical cavities at ends instead of circular holes. Paper read before Instn. Naval Architects.

Safety at Sea

Safety of Life at Sea, Westcott Abell. Eng., vol. 110, no. 2846, July 16, 1920, pp. 91-93, 3 figs. View is expressed that factorial system of subdivision is incorrect in principle, and very small changes in size of vessel may give rise to large increases in risk of loss. It is suggested that scheme of subdivision more in accord with history consisting of combinations of "one" and "two" compartment standards can be arranged (1) to give rational system and graduated increase of safety with increase of length, (2) to give better standard of safety than is contained in present regulations, (3) to be capable of adjustment for variation in numbers of passengers carried, and (4) to meet reasonably economic requirements of cargo transportation. Paper read before Instn. Naval Architects.

Welded

The Development of Welded Ships, William T. Bonner. Jl. Engrs.' Club of Philadelphia, vol. 37-7, no. 187, July, 1920, pp. 275-279, 8 figs. Author concludes that properly designed welded ships are lighter, stronger, less expensive, and more efficient than those of the present riveted type. Following description of various methods of welding and statement of present attitude of Lloyd's and other classification societies toward allowing welding on ships, suggestions are offered for guidance of designing engineers in elimination of needless materials and use of short cuts in construction and erection work. Delivered before Delaware River section of Am. Soc. Mar. Draftsmen.

SHIPYARDS

England

The Armstrong Shipyard. Eng., vol. 109, no. 2838, May 21, 1920, pp. 695-698, 5 figs. Details of power station. (Concluded.)

The Birkenhead Works of Messrs. Cammell Laird & Co., Limited. Eng., vol. 109, no. 2842, June 18, 1920, pp. 812-819, 19 figs., partly on 4 supp. plates. Description of Birkenhead shipyard and engine works.

Mechanical Equipment

Machinery in the Shipyard and Its Increasing Importance Under Present-Day Conditions (Die Maschinenwirtschaft auf der Werft und ihre erhöhte Bedeutung für die Jetztzeit), H. Wintermeyer. Shiffbau, vol. 21, nos. 25 and 26, May 12 and 19, 1920, pp. 683-687 and 710-713, 13 figs. Notes on power transmission by shafting and on steam, pneumatic, electric and hydraulic machines and tools employed.

SILVER METALLURGY

Silver-Tin Ore Treatment

Roasting and Chloridizing of Bolivian Silver Tin Ores, M. G. F. Söhnlein. Min. & Metallurgy, no. 164, Aug. 1920, pp. 21-22, 2 figs. Ore is crushed dry, given chloridizing roast, leached with water and hyposulphite solution to extract gold, silver and copper, and concentrated for tin with or without regrinding. (Abstract).

SMOKE ABATEMENT

Salt Lake City

Fuel Utilization and Smoke Abatement in Salt Lake City, Osborn Monnett. Power, vol. 52, no. 3, July 20, 1920, pp. 204-207, 4 figs. Report by Bureau of Mines in coöperation with City of Salt Lake and University of Utah.

SNOW SWEEPERS

Filling Rotary Brushes

Machine for Filling Snow Sweeper Brushes. Elec. Ry. Jl., vol. 56, no. 2, July 10, 1920, pp. 87-77, 1 fig. Built in shops of Cleveland Ry., said to have effected marked economy in filling of rotary brooms.

SOUND

Water-Borne, Receivers for

The Theory of Receivers for Sound in Water, H. A. Wilson. Physical Rev., vol. 15, no. 3, sec. series, Mar., 1920, pp. 178-205, 9 figs. After proving that a receiver must have a small volume to be efficient, author considers in detail case of small spherical receiver connected to ear by a cylindrical tube, and it is shown that a resonating receiver with properly chosen tube may concentrate into tube energy from an area about 850 times the cross-section of tube. Equations are derived for case of symmetrically arranged receivers, all equidistant from source of sound. Conditions for complete transmission for given frequency are determined for case of small receivers mounted in a plane in front of a totally reflecting parallel surface.

SPARK PLUGS

Causes of Failure

The General Causes of Failure of Spark Plugs, F. B. Silsbee. Automotive Industries, vol. 43, no. 2, July 8, 1920, pp. 66-71. Analysis of possible causes of defective spark-plug action due to design, and suggested remedies for difficulties. Data obtained from tests on many varied designs and reports from France.

SPLINES

Involute

Methods of Generating the Involute Spline and its Application, Douglas T. Hamilton. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 149-154, 4 figs. Brief outline of advantages claimed for involute splines: They possess greater possibilities for securing interchangeability between parts; the involute can be generated much more accurately; the involute has a tendency to keep the parts concentric with each other and when used in an automobile transmission this would have the advantage of decreasing the noise of the gears; and number of standards considerably reduced, resulting in lower tool and manufacturing costs.

STANDARDIZATION

Safety Movement, and

Standardization and the Safety Movement, Chas. E. Oakes and J. A. Dickinson. Am. Mach., vol. 53, no. 1, July 1, 1920, pp. 9-10. Examples offered to show need for standardization, such as standardization of safety codes for use of various states, municipalities and insurance companies.

Tolerances

Tolerances in Mechanical Constructions (Les "tolerances" dans la construction mécanique), L.-V. Bournat. Technique Moderne, vol. 12, no. 1, Jan. 1920, pp. 17-22, 4 figs. Comparative survey of maxima and minima values prescribed for tolerances in standards formulated by different standardization commissions, notably German Standardization Commission.

STEAM ENGINES

Robey Compound Superheater Engine

The Works of Messrs. Robey and Co., Limited, of Lincoln. Eng., vol. 110, no. 2847, July 23, 1920, pp. 104-106, 16 figs. partly on supp. plates. Details of Robey compound superheater engine. (Concluded).

Uniflow

The Uniflow Steam Engine, F. B. Perry. Eng., vol. 110, no. 2848, July 30, 1920, pp. 162-164, 6 figs. Principle of operation and details of construction. Paper read before Instn. Mech. Engrs.

[See also LOCOMOBILES.]

STEAM GENERATORS

Electrically Operated

Electrically-Operated Steam Generators, E. G. Constam-Gull. Can. Engr., vol. 39, no. 7, Aug. 12, 1920, pp. 231-234, 4 figs. Results obtained in official tests of steam generators electrically operated which are being used in hydroelectric installation in Switzerland. High efficiency attained corresponds to evaporation of 2.9 lb. of so-called standard steam per kilowatt-hour. Steam produced had content of water of only about 3 per cent. compared with steam of 5 to 10 per cent humidity produced by ordinary fired boilers.

STEAM POWER PLANTS

Design

Power Station Design in Relation to Thermal Efficiency, I. V. Robinson. Engr., vol. 129, no. 3365, June 25, 1920, pp. 655-656. Developments in power-station design leading to greater thermal efficiency are classified into (1), increase in range of working temperatures of steam, (2), saving of low-grade heat, and (3) increase in size of generating sets. Paper read before Incorporated Municipal Elec. Assn. Convention.

Reconstruction

Reconstruction of a Power Plant Under Operation, Thorleif Fliflet. Power, vol. 52, no. 3, July 20, 1920, pp. 82-84, 3 figs. Power production is said to have maintained at normal in plant of Surpass Leather Co., Philadelphia, Pa., over entire period during which battery of seven old return-tubular boilers was replaced, two at a time, by three water-tube stoker-fired boilers.

STEAM REGENERATORS

Requirements of

Steam Regenerators Reduce Coal Consumption, W. H. Schacht. Min. & Metallurgy, no. 164, Aug. 1920, pp. 32-33. Method for regulating regenerator requirements. (Abstract.)

STEAM TURBINES

Calculations

The Application of the v^2-Method in the Calculation of Steam Turbines (Ueber die Verwendung der v^2-Methode bei der Berechnung von Dampfturbinen), R. Fichtner. Zeitschrift für das gesamte Turbinenwesen, vol. 17, no. 9, Mar. 20, 1920, pp. 97-100, 6 figs. In the usual v^2-method with charging of the v^2 against the heat content, a change is made by charging against the adiabatic drop and use of velocity coefficients; it is shown by examples that both methods agree fundamentally and differ only in velocity of efflux.

Operation and Adjustment

Operation and Adjustment of Turbine Machinery—I, II and III, Eustis H. Thompson. Power, vol. 52, nos. 1, 3 and 5, July 6, 20 and Aug. 3, 1920, pp. 2-4, 85-87 and 181-183, 6 figs. Concerning leveling of turbines, assembly of casing, and aligning of bearing pedestals. Inspecting machine before setting it in motion. Examining and starting large turbines after their erection.

STEEL

Cold-Rolling

Study Stresses in Cold Rolling, Henry M. Howe and E. C. Groesbeck. Iron Trade Rev., vol. 66, no. 26, June 24, 1920, pp. 1824-1825, 6 figs. Investigation indicated that internal stress increases with amount of reduction per pass due to skin friction of rolls, and that elongation is independent of number of passes. Paper read before Am. Soc. Testing Materials.

Ingot Tests

Tests Sink-Head Ingots. Iron Trade Rev., vol. 67, no. 2, July 8, 1920, pp. 114-116, 4 figs. Bureau of Standards' experiments at Maryland Steel Co. plant. Ingots from English plant compared favorably with steel cast by ordinary practice for rails.

Ingots, Cracks in

Cracks in Ingots, Federico Giolitti. Chem. and Metallurgical Eng., vol. 23, no. 4, July 28, 1920, pp. 149-153, 13 figs. Demonstration that one class of deep-seated cracks is due to generation of parasitic centers of crystallization in undercooled regions of melt, with the result that adjoining phenocrysts are of widely different composition.

Physical Properties

The Effect of Initial Temperature upon the Physical Properties of Steel, J. H. Andres, J. E. Rippon and C. P. Miller. Iron & Steel Inst., advance proof (meeting, May 6 and 7, 1920), 82 pp., 76 figs., 5 on supp. plate. Effect of variation in initial temperature upon position of resulting transformation points in certain nickel, chromium and nickel-chromium steels is determined. Volume change at normal transformation points, as shown by dilatometer, found to be composed of two changes working in opposition—allotropic change, and change due to carbide; quenching merely stereotypes condition of carbide, which in its turn controls allotropic change; nickel-chromium steels behave in much the same way as carbon steel, except that in latter time factor necessary to produce same changes in carbide is of much lower order; in tested carbon steels, quenched at 1000 deg. cent. iron product is in alpha state.

Shearing at High Temperatures

Energy Necessary to Shear Steel at High Temperatures, Guy D. Newton. Univ. of Mo. Bul., vol. 21, no. 4, Feb. 1920, 16 pp. 10 figs. Tests made to determine shearing resistance of steel at working temperature.

Surface Changes When Heated in Vacuo

Surface Changes of Carbon Steels Heated in Vacuo, E. Heaton Himingway and George R. Ensminger. Min. & Metallurgy, no. 164, Aug. 1920, p. 24. Three types of markings were observed when samples of steel were held at 1000 deg. cent. in vacuo for a few hours: (1) Deeply marked polyhedral structure which represented final gamma boundaries; (2) fine clean-cut structure representing alpha boundaries; and (3) indefinite, and often partly obliterated structure representing boundaries of former gamma crystals that had been absorbed by crystalline growth. (Abstract.)

[See also CHROME-NICKEL STEEL: NICKEL STEEL: STRUCTURAL STEEL.]

STEEL, HEAT TREATMENT OF

Chrome Steel

The Heat Treatment of a High-Chromium Steel, H. J. French and Yoshito Yamauchi.

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ENGINEERING INDEX (Continued)

Chem. & Met. Eng., vol. 23, no. 1, July 7, 1920, pp. 13-16, 11 figs. Study of relation of various heat treatments on physical properties and microscopic appearance of stainless steel. Comparatively high-temperature annealing is said to be required to alter structure of hardened material. Published by permission of Director, Bur. of Standards.

Hardening

Hardening Practice (Härtepraxis). Werkstattstechnik, vol. 14, no. 6, Mar. 15, 1920, pp. 170-174. Abstracts from book with same title by Carl Scholz, with notes on quenching tanks and arrangements, and hardening tongs; quenching and tempering methods; determination of proper hardening temperature; annealing; hardening of carbon steel and high-speed tool steel; case-hardening; and blueing and marbleizing of iron and steel sections.

Spring Steel

Selective Heat Treatment of Spring Steel; E. P. Stenger. Iron Age, vol. 106, no. 1, July 1, pp. 1-3, 2 figs. Experience of company during war. Spring steel with carbon content ranging from 0.90 to 1.05 per cent was needed and only materials obtainable were limited quantities of steel having 0.80 to 0.90 per cent carbon and 1.05 to 1.15 per cent carbon. System of selective heat treatment installed to meet variations in composition is explained.

STEEL MANUFACTURE

Casting and Molding Ingots

Casting and Molding Steel Ingots, Emil Gathmann. Min. & Metallurgy, no. 164, Aug. 1920, pp. 29-31. Best results as to freeedom from surface blowholes, snakes, etc., in evolution steels are said to be obtained when ingots are bottom cast. Method by which similar results were obtained with other steels is described which consisted of employing special teeming or pouring nozzle whereby pressure and velocity of liquid steel as it entered mold was greatly reduced, without, however, reducing quantity or volume per minute of steel teemed. (Abstract.)

Tilting Furnaces

Tilting Furnaces Used for Steel Manufacture (L'emploi des fours oscillants pour la fabrication de l'acier). Génie Civil, vol. 76, no. 25. June 19, 1920, pp. 545-548, 4 figs. Wellman steel works in Staffordshire, England.

STOKERS

See FURNACES, BOILER. Air Cooled Scraper Grate.

STORAGE BATTERIES

Non-Liquid

New Non-Liquid Storage Battery of Durable Construction. Automotive Industries, vol. 42, no. 4, July 22, 1920, p. 157. Storage battery without a liquid electrolyte and with many of the features of a primary cell.

STORM WATER

Run-Off

Storm Water Run-Off Diagram for Rational Method, George C. D. Lenth. Eng. News-Rec., vol. 85, no. 4, July 22, 1920, pp. 151-152, 1 fig. Diagram made to give run-off on given area in second-feet, when time of concentration, area, and ratio of run-off to rainfall has been determined.

STREET CLEANING

Methods

Report on Investigation and Study of Methods of Street Cleaning, Collecting and Disposal of Municipal Waste in Other Cities—Recommendation and Plan of Procedure for Philadelphia, J. H. Neeson. Jl. Engrs. Club of Phila., vol. 37-8, no. 188, Aug. 1920, pp. 336-340. It is recommended that service of cleaning of streets, collecting ashes, rubbish and garbage should be given to the public at cost by municipal forces.

Report on the Study of the Methods of Street Cleaning and Collection and Disposal of Municipal Wastes, E. B. Morden, J. F. Follin and J. H. Neeson. Jl. Engrs. Club of Phila., vols. 37-8, no. 188, Aug. 1920, pp. 326 336. Data collected in inspection tour of 15 of principal cities of United States.

STREET RAILWAYS

Cars, Safety

Battery Cars Changed to Safety Cars, R. H. Parsons. Elec. Ry. Jl., vol. 56, no. 7, Aug. 14, 1920, pp. 311-314, 10 figs. Details of conversion of 50 storage-battery cars to safety cars for one and two-man operation by Third Avenue Railway, New York, for use in outlying districts.

The Safety Car, W. D. Bearce. Gen. Elec. Rev., vol. 23, no. 7, July 1920, pp. 597-6-5, 13 figs. Operating figures from various parts of the country.

Freight Cars for

Four-Axled Cars for Freight Transportation on Street Railway Tracks (Vierachsige Wagen für Güterbeförderung auf Strassenbahnen), H. Otto. Verkehrstechnik, vol. 37, no. 5, Feb. 15, 1920, pp. 66-67, 2 figs. Description of 5-ton metergage car constructed by firm of Krupp and now in operation. Dimensions: Maximum length above buffer head, 10,120 mm.; maximum width, 2000 mm.; height, 1200 mm.

STREETS

Double Deck

Chicago Double Deck Street for Congested District. Eng. News-Rec., vol. 85, no. 4, July 22, 1920, pp. 173-175, 4 figs. Traffic separation is main purpose. Automobile parking space, wharfage and freight house facilities included.

STRUCTURAL STEEL

Standard Shapes

Proposes Standards for Shapes. Iron Trade Rev., vol. 67, no. 1, July 1, 1920, pp. 43-44, 3 figs. Section Committee of Am. Standards Committee formulates basis for Anglo-American standards for structural shapes. British bulb angle sections and new channel and beam sections are recommended.

Wide-Flange Beams

Wide Flange Beams by the Sack Method. Iron Age, vol. 106, no. 8, Aug. 19, 1920, pp. 448-449, 8 figs. Results of German practice in producing shapes like those of Bethlehem mill. Roll design and theory of process. (To be concluded.) Translated from Stahl und Eisen.

SUBMARINE CABLES

Tests

Induction Disturbances in the Anglo-German Telegraph Cables and Their Elimination. (Induktionsstörungen in den deutsch-englischen Telegraphenkabeln und Ihre Beseitigung.) A. Kunert. Telegraphen- u. Fernsprech-Technik, vol. 8, no. 12, Mar. 1920, pp. 202-216, 21 figs. Results of tests with the double-line operation show that the two cable loops by double Baudot ensure an entirely reliable operation, and with adequate improvement of the artificial lines they permit a triple and probably quadruple Baudot. Double-line operation is shown to be the best and simplest means of overcoming induction disturbances.

Measurements on Guttapercha Telegraph Cables with Single Conductors by Means of Alternating Currents of Low Frequency. (Messungen an Guttapercha-Telegraphenkabeln mit Einzeladern mittels Wechselströmen niederer Frequenz), A. Kunert. Telegraphen- u. Fernsprech-Technik, vol. 8, no. 12, Mar. 1920, pp. 189-198, 13 figs. Results of measurements show among other things that a noticeable influence of insulation of adjoining conductors in the case of multi-conductor cables is first apparent at a higher frequency than 100; the so-called conductivity constants are not constants; increase of copper resistance with increasing frequency is much greater than was to be expected from theory, etc. (Concluded.)

SUBMARINE WARFARE

Experiments

Model Experiments in Connection with Submarine Warfare, G. S. Baker. Eng., vol. 109, no. 2840, June 4, 1920, pp. 770-773, 5 figs. Work done at the Tank, England. Paper read before Instn. Naval Architects.

SUBMARINES

German

German Submarine Minelayers. Engr., vol. 129, no. 3356, April 23, 1920, pp. 415-416. Tables giving general characteristics and weights and percentages of displacements of classes UC-I, UC-II and UC-III. Translated from Schiffbau.

The Development, Construction, Purpose and Uses of the German Submarine Boats (Die Entwicklung, Bauart, Zweck und Verwendung der deutschen Unterseeboote), Goswin Flügge. Schiffbau, vol. 21, nos. 27 and 28, May 26 and June 2, 1920, pp. 739-745 and 767-776, 7 figs. Gives details of construction and of engine installations in U-boats, and points out that during the last years of the war 100 boats were put into service annually; water displacement of the first U-boat was only 238 tons as compared to 2094 tons of U-boat 142; engine capacity was increased from 400 to 6000 hp., and for electric-motor capacity, from 400 to 2600 hp.; speed was increased from 9 to 18 knots.

SUBWAYS

Automatic Route Indicator

The Silent Guide Automatic Route Indicator. Engr., vol. 129, no. 3355, April 16, 1920, pp. 408-409, 3 figs. Chart provided with electric connections and lamps. By pressing push button placed opposite name of station in list on side of map, lamp at position of station on map is lighted and route to take to reach it is indicated by color scheme.

Signaling

Electric Signaling in the Paris Underground Railway (La signalisation électrique du chemin de fer métropolitain de Paris), M. Koch. Électricien, vol. 35, no. 1253, June 1, 1920, pp. 225-229, 8 figs. Block-system is used. Schemes of connection are given.

T

TAR

Characteristics

Characteristics of Primary Low-Temperature Tar, Franz Fischer. Chem. & Met. Eng., vol. 23, no. 2, July 14, 1920, p. 70. States that it must be liquid at room temperature; its specific gravity at 25 deg. cent. must correspond to 0.95-1.06; on thin layer it is a golden-red to port-wine colored oil; in fresh state it smells nearly always of sulphuretted hydrogen or sulphide of ammonium, and in no case should it smell of naphthalene. Translated from Zeitschrift für angewandte Chemie, 1920.

Producer-Plant Manufacture

Producer Plant for Production of Tar (Generatoranlage für Urteergewinnung), H. Gwosdz. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 12-13, Mar. 26, 1920, pp. 89-90, 1 fig. Describes plant equipped with apparatus built by Ehrhardt & Sehmer, with details of coking retort. Separation of tar is effected in a series arrangement of apparatus by washing and compression. The gas from dust separator is transmitted by means of a disintegrator in which the tar vapors are precipitated with aid of injected hot tar.

TAYLOR SYSTEM

Application of

Logical Steps in Installing the Taylor System of Management, H. K. Hathaway. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 89-96. Application and practice of Taylor system. First article of series.

TELEPHONY

Automatic

Automatic Telephony (La téléphonie automatique), Armand Bocquet. Société Belge des Électricians, vol. 34, April-June 1920, pp. 77-85, 3 figs. European and American systems.

Cross-Talk in Combined Circuits

Cross-Talk in Combined Telephone Circuits (Uber das Nebensprechen in kombinierten Fernsprechkreisen), Leon Lichtenstein. Elektrotechnische Zeitschrift, vol. 41, nos. 10 and 11, Mar. 4 and 11, 1920, pp. 188-191 and 208-212, 15 figs. Account of experiment with a theory of cross-talk in combined telephone circuits, based on a system of four parallel lines. Simple formulæ are derived and discussed in detail.

Switchboard Cables

Heating of Switchboard Cables. Post Office Elec. Engrs. Jl., vol. 13, no. 2, July 1920, pp. 116-122, 5 figs. Results of tests made upon telephone switchboard cable of 23 S. W. G. wires, to prove that no excessive heating could occur with the use of these wires in certain telephone circuits. Tests also gave information upon heat conductivities of insulating materials.

TERMINALS, MARINE

Mechanical Equipment

Saving $400,000,000 with Mechanical Equipment for Railway and Steamship Terminals, Harwood Frost. Eng. & Indus. Management, vol. 4, no. 5, July 29, 1920, pp. 153-156, 1 fig. Service rendered by mechanical equipment in Brooklyn army base, Newark, Boston and other terminals built by Construction and Storage Division of the War Dept. during the war. (To be continued). Paper read before Soc. of Terminal Engrs.

TERMINALS, RAILWAY

American Expeditionary Forces

Terminals Built on the Orléans Railway by the Americans During the War (Gares Américaines éstablies pendant la Guerre sur le réseau d'Orléans), M. Epinay. Revue générale des Chemins de Fer, vol. 39, no. 5, May 1920, pp. 329-346, 15 figs. Details of terminals noting specially differences between American and French design practices.

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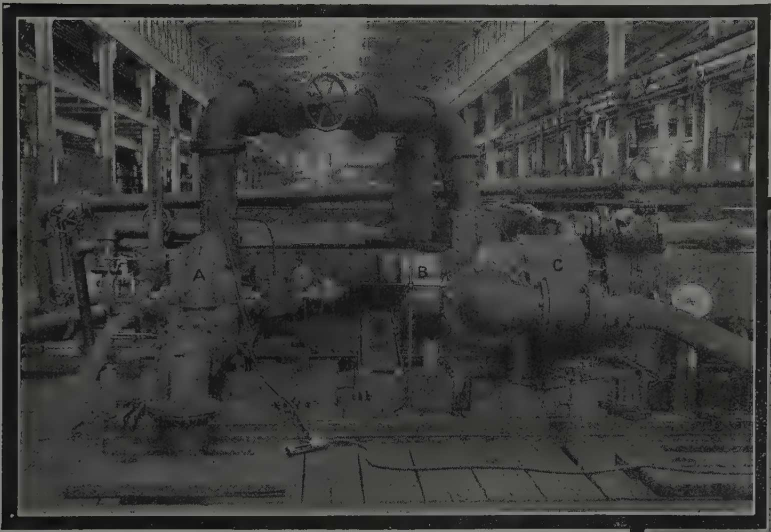

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ENGINEERING INDEX (Continued)

THERMOELECTRICITY

Mercurial

Thermoelectricity of Liquid Mercury (Vérification de la thermoélectricité du mercure liquide), M. Goineau. Comptes rendus des Séances de l'Académie des Sciences, vol. 170, no. 26, June 28, 1920, pp. 1567-1570, 1 fig. Experiments confirming M. C. Benedick's discovery announced in Comptes rendus, vol. 163, 1916, p. 751, that in a homogeneous metallic circuit an asymmetric distribution of temperature gives rise to an electromotive force.

TIDES

Electrical Disturbances Due to

On Electrical Disturbances Due to Tides and Waves, F. B. Young, H. Gerhard and W. Jevons. Lond., Edinburgh and Dublin Philosophical Mag. & Jl. of Sci., vol. 40. no. 235, July 1920, pp. 149-159. Experimental results are said to clearly indicate existence of periodic e.m.f.'s in sea whose period and magnitude show them to be result of earth induction in tidal currents; high values obtained from drifting electrodes indicate that the e.m.f.'s due to purely local induction which are measured by moored electrodes is small, and those actually measured by these electrodes are due principally to more remote tidal currents.

TIME STUDY

Cutting Time for Planer Jobs

Chart for Computing Planing Time, J. B. Conway. Am. Mach., vol. 53, no. 8, Aug. 19, 1920, pp. 351-352, 1 fig. Chart constructed from formula ordinarily used for calculating time required for planing.

Mining Operations

Standardizing at North Butte Mining Co., Robert Linton. Min. & Metallurgy, no. 164, Aug. 1920, pp. 31-32, 2 figs. Methods of applying time studies to mining operations. (Abstract.)

Production Basis

Time Study as Basis of Production, J. A. Bennie. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 99-102, 1 fig. Example of time study.

Stop-Watch Readings

Scientific Management, Henry Atkinson. Eng. & Indus. management, vol. 4, no. 5, July 29, 1920, pp. 131-135, 8 figs. Method of recording stop-watch readings. Description of cyclegraph.

Working Up Time Studies

Time and Job Analysis in Management—V, William O. Lichtner. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 130-139, 8 figs. How to work up and use time studies. Examples of dangers to avoid and methods to follow.

TOWN PLANNING

Philadelphia

City Planning and Zoning in Philadelphia, James W. Follin. Jl. Engrs. Club of Phila., vols. 38-8, no. 188, Aug. 1920, pp. 316-326. Review of activities during past 25 years.

TRACTOR ENGINES

Kerosene as Fuel

Kerosene as a Tractor Fuel, John A. Secor. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 140-143 and (discussion), 144, 156. Discusses kerosene tractor-engine development, fuel consumption, regulating heat conditions, etc.

TRACTORS

Manufacture

Special Machines in a Tractor Shop. Machy. (London), vol. 16, no. 410, Aug. 5, 1920, pp. 549-552, 7 figs. Special machines designed for producing tractor parts.

Steam

Liquid-Fuel-Fired Steam Motor Wagon. Eng., vol. 109, no. 2837, May 14, 1920, pp. 644-645, 5 figs. Application to steam motor wagon of liquid-fuel firing on pressure-jet system.

TRADE UNIONS

Future of

What Are We Likely to Do About Labor Unions? E. H. Fish. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 109-112. It seems to writer that securing by labor of "a larger share of proceeds of its own production" by violence "had to be gone through as a part of the education of employers, and also partly as education for workmen." He believes that "this sort of revolution . . . can stop whenever each side is convinced that it has measured its opponent's strength," and "when each side respects the other."

TRANSFORMERS

Standardization

Regulation for Maximum Value of Ratio No-Load Current/Load Current of Single-Phase and Three-Phase Transformers of 25 and 50 Periods per Second (Réglement pour les valeurs maxima du rapport: courant à vide/courant en charge des transformateurs monophasés et triphasés à 25 et 50 p:s). Revue générale de l'Électricité, vol. 8, no. 1, July 3, 1920, pp. 22-23. Regulation adopted on April 14, 1890, by the Union des syndicates de l'Électricité.

TRESTLES

Renewal Under Heavy Traffic

Renewing a Trestle Under Heavy Traffic. Ry. Maintenance Engr., vol. 16, no. 8, Aug. 1920, pp. 301-302, 2 figs. Replacing of open-deck trestle almost entirely of untreated timber by creosoted timber ballasted-deck pile trestle.

TUNNELS

Vehicular

Driving with Air the Hudson Vehicular Twin Tubes, Robert G. Skerrett. Compressed Air Magazine, vol. 25, no. 8, Aug. 1920, pp. 9741-9749, 13 figs. Engineering analysis of project which is to cost $28,670,000.

TURBO-GENERATORS

Oil Temperature Recorder

An Electrical Device for Checking the Oil Temperature of Medium-Sized Turbo-Generators, Geo. J. Duckett. Electrician, vol. 85, no. 2200, July 16, 1920, pp. 76-77, 6 figs. Description of automatic device used to record at a distance exactly the state of affairs through which lubricating oil is passing at any time, and also controller which automatically adjusts quantity of water passing through the oil cooler.

10,000-kw. Unit

New Power Plant of National Tube Co., J. W. Marshall. Blast Furnace & Steel Plant, vol. 8, no. 8, Aug. 1920, pp. 466-469, 4 figs. Description of 10,000-kw. turbo-generator unit.

V

VACUUM

High

See PUMPS, Vacuum.

VACUUM TUBES

Helium Discharge Tubes

Symmetrical Subdivision of Anode Glow in Helium Discharge Tubes, G. M. J. Mackay. Physical Rev., vol. 15, no. 4, sec. series, Apr. 1920, pp. 309-311, 2 figs. When a continuous electrical discharge passes through helium at a pressure of 2 cm., the anode glow may break up into a number of spots more or less regularly distributed.

Input Impedance

Note on the Input Impedance of Vacuum Tubes at Radio Frequency, Julius Weinberger. Proc. Inst. of Radio Engrs., vol. 8, no. 4, Aug. 1920, pp. 334-339 and (discussion) pp. 340-341, 3 figs. It is shown experimentally that input impedance of three-element vacuum tube at radio frequency is not infinite, as heretofore supposed, but that because of capacitive coupling between input and output circuits within tube itself, input impedance greatly depends on character of output circuit. General effect of inductive and capacitive output circuits is mentioned.

Three-Electrode

Calculation of the Constants of the Three-Electrode Thermionic Vacuum Tube, Robert W. King. Physical Rev., vol. 15, no. 4, sec. series, Apr. 1920, pp. 256-268, 6 figs. Reference is made to H. J. van der Bijl experiments with view to finding empirical relations between tube dimensions and electrical properties, which, it is claimed, have been of greatest value in connection with subsequent design of tubes for various purposes; and author attempts to arrive at similar set of relations by a theoretical analysis of the tube. Numerical agreement obtained in most cases is said to be good, and to be usually within limits of variation found among number of tubes of some specifications.

Uses

Vacuum Tubes and Their Uses (Les tubes a décharge électronique et leurs applications), P. Letheule. Génie Civil, vol. 76, no. 23, June 5, 1920, pp. 508-512, 6 figs. Details of L. de Forest audion and dynatron. (Concluded.)

VALVES

Pressure-Reducing

Heat Accumulation in Pressure-Reducing Valves and Its Dangers (Wärmestauungen in Druckminderventilen und ihre Gefahren). Autogene Metallbearbeitung, vol. 13, no. 2, Jan. 15, 1920, pp. 13-16, 9 figs. Various arrangements and devices for use with gas bottles are described, but it is claimed that many of existing pressure-reducing valves in use in Germany are not designed with sufficient regard to elimination of dangerous compression heat, and means and methods are suggested for making practical improvements. (Concluded.)

VENTILATION

Synthetic Air Chart

The New Measure of Ventilation, E. Vernon Hill. Heat & Vent. Mag., vol. 17, no. 8, Aug. 1920, pp. 27-29, 2 figs. Instructions for using synthetic air chart recently adopted by Soc. of Heat & Vent. Engrs. Chart is designed as means of accurately measuring air conditions maintained in any given room.

W

WAGES

Extra Pay for Families

Extra Pay for Families. Iron Age, vol. 106, no. 5, July 29, 1920, p. 277. System of allowances in French metal-working industries.

Hours of Labor and

Wages and Hours of Labor. Monthly Labor Rev., vol. 10, no. 6, June 1920, pp. 82-115. Tables presenting a summary report on industries, including manufacture of machinery, machine tools, and typewriters, automobiles, cars, electrical apparatus and foundry industry. Wages and hours of labor in anthracite and bituminous coal mines, rise of wages in British industries, etc.

Minimum

Minimum Quantity Budget Necessary to Maintain a Worker's Family of Five in Health and Decency. Monthly Labor Rev., vol. 10, no. 6, June 1920, pp. 1-18. Prepared by Bur. of Labor Statistics.

Payment, Systems of

Wage Payment Administration and Its Relation to Production Control, Paul Faltin and Leon Blog. Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 139-142, 2 figs. Piece-work method of payment is advocated as more efficient than day-work method. It is urged, however, that in computing rate difference should be recognized between cases where output is primarily controlled by machines and cases where it depends almost wholly upon human element. Examples are given.

Production Basis for

The Human Element in Production, A. F. Knobloch. Jl. Soc. Automotive Engrs., vol. 7, no. 2, Aug. 1920, pp. 137-139. Writer believes that workman must be paid in the ratio of production secured from him, and that without endangering his future. Describes how one plant has solved the problem.

U. S. Government's Policy

The Government's Wage Policy During the Last Quarter Century, Mary Conyngton. Monthly Labor Rev., vol. 10, no. 6, June 1920, pp. 19-35, 2 figs. Gives tables based on figures furnished to Commission on Reclassification by various bureaus, divisions and groups concerned, and used by Commission as a basis of a series of charts prepared under direction of Bur. of Education.

WARSHIPS

Destroyers

An Application of the Method of Analyzing the Engineering Performance of Destroyers, Wentworth H. Osgood. U. S. Naval Inst. Proc., vol. 46, no. 8, Aug. 1920, pp. 1223-1249, 23 figs. Explains by means of definitions and specific examples elements which constitute analysis of engineering performance of destroyers. Suggestions for practical application of analysis aboard ship are given. Installations aboard U. S. S. Blakeley are taken as basis.

German Naval Construction, 1914-1918—II. Engr., vol. 129, no. 3365, June 25, 1920, pp. 642-644. List giving particulars of German destroyers completed during war.

Incinerators for

Incinerator and Disinfector for Naval Service. Eng., vol. 109, no. 2843, June 25, 1920, pp. 854-855, 6 figs. Incinerator installed in battleship Hood.

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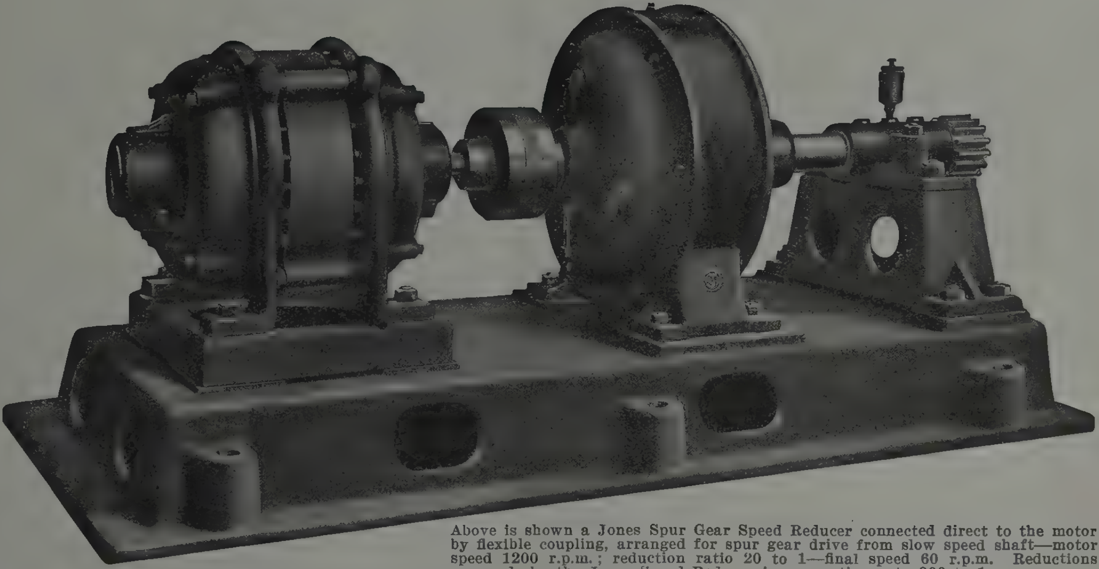

Above is shown a Jones Spur Gear Speed Reducer connected direct to the motor by flexible coupling, arranged for spur gear drive from slow speed shaft—motor speed 1200 r.p.m.; reduction ratio 20 to 1—final speed 60 r.p.m. Reductions are made by the Jones Speed Reducer in any ratio up to 200 to 1.

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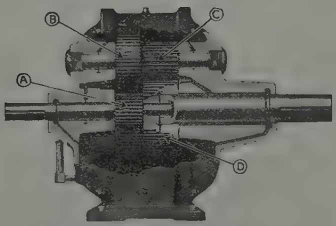

A—Pinion meshes with and drives three gears B.
B—Gears are mounted integral with the three pinions C.
C—Pinions mesh with and drive slow speed gear D.

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ENGINEERING INDEX (Continued)

Mechanical Reduction Gears

Experience and Practice in Mechanical Reduction Gears in Warships, H. B. Tostevin. Engr., vol. 129, no. 3355, April 16, 1920, pp. 405-407, 6 figs. Development is briefly traced, experience gained is indicated, and general practice of British Admiralty as regards details of gears is given. Paper read before Instn. Naval Architects.

U. S. S. Tennessee

The United States Battleship Tennessee, James L. Bates. Int. Marine Eng., vol. 25, no. 8, Aug. 1920, pp. 642-643 and 656, 1 fig. Vessel is 625 ft. long, has a beam of over 97 ft. and displaces 32,300 tons. Main battery consists of twelve 14-in. guns, and vessel has heavy belt of armor. Maximum speed is 21 knots. Vessel is electrically driven.

WASTE HEAT

Utilization of

Waste-Heat Utilization in Steel Works. (Abfallwirtschaft in Eisenhüttenwerken), H. Hermanns. Verhandlungen des Vereins zur Beförderung des Gewerbfleisses, no. 1, Jan. 1920, pp. 6-14 and (discussion) pp. 14-16. Recommends a better utilization of the available fuels by extended use of waste fuels and of gas, which is all the more important because of recovery of low-temperature tar; economic utilization of energy content in exhaust gases, reserving high-grade gases for such heat processes where they can be most advantageously employed; utilizing waste heat from smelting, heating and annealing furnaces for generation of steam, waste heat from steam engines for heating purposes, utilization of natural heat of producer gas, and of clinker heat for generation of steam, etc.

WATER FILTRATION

Testing Station Results

Milwaukee Testing Station Results on Filtration of Water. Eng. News-Rec., vol. 85, no. 6, Aug. 5, 1920, pp. 257-259. Hydraulic jump has been found to make excellent coagulant mixer, slat underdrains are proven effective, but cost of ozone treatment has been found to be too high.

WATER MAINS

Jointing Compounds

The Efficiency of Pipe Jointing Compounds as Compared with Lead, Fred O. Stevens. N. E. Water Works Assn., Jl., vol. 34, no. 2, June 1920, pp. 102-104 and (discussion) 105-113. Writer urges that water-works managers and engineers try out the value of substitutes. Gives tests to show satisfactory use of several compounds.

WATER POWER

Federal Act

Provisions of the Federal Water-Power Act. Eng. News-Rec., vol. 85, no. 5, July 29, 1920, pp. 204-208. Abstract of law creating federal power commission and permitting long-time use of water on government lands and navigable streams.

Utilization, Recent Advance

Recent Advances in Utilization of Water Power, Eric M. Bergstrom. Jl. Instn. Mech. Engrs., nos. 1 and 2, Feb. and Mar. 1920, pp. 55-128, 129-151, and (discussion) 152-158, 51 figs. Also Eng., vol. 109, no. 2822, no. 2823, no. 2824, Jan. 30, 1920, Feb. 6, 1920, Feb. 13, 1920, pp. 140-143, 191-197 and pp. 227-232, 50 figs. Outstanding developments enumerated are: Exclusive use of Francis reaction turbines for low and medium heads and Pelton impulse wheels for high heads; extension of use of Francis turbines under heads approaching 800 ft., and Pelton wheels in single stage up to 5,500 ft.; exclusive adoption of balanced wicket gates for regulation of Francis turbines and circular nozzle with combined deflector and needle regulation for Pelton wheels; standardization of turbine runners and increased specific speed; increase of output per unit, maximum output at present being 31,200 b.hp.; increase of overall efficiency; exclusive use of oil-pressure governors; efficient regulation by means of differential surge tanks of turbines using long pipe lines; and employment of large diameter pipe lines under high heads.

WATER SUPPLY

Conduit Capacity and Storage

Estimation of Conduit Capacity in Relation to Storage, Frederic H. Hapgood. Eng. News-Rec., vol. 85, no. 4, July 22, 1920, pp. 153-154, 1 fig. Calculations made in connection with studies for new water supply for New Britain, Conn. Problem was finding most economical combination of capacities of retarding reservoir and pipe line to provide sufficiently complete development of drainage area selected.

Pumping by Hydraulic Power

Pumping Croton Water by Hydraulic Power: Water Supply of New York, Winfred D. Hubbard. Jl. of Am. Water Works Assn., vol. 7, no. 4, July 1920, pp. 461-470, 2 figs. Only approximately 50 per cent of Croton has been in use because of low service. It is planned to use centrifugal pumps which would take Croton water from low-service mains and deliver it to intermediate service, which is much more in demand.

Waste Control

Water Waste Control. Jl. of Am. Water Works Assn., vol. 7, no. 4, July, 1920, pp. 488-515, 2 figs. Informal discussion by New York Section of Assn. Deals with conditions in New York City and vicinity and in Buffalo, N. Y.

WATER WORKS

Appliances, Standardization of

Standardization of Water Works Appliances, Adolph Mueller. Contract Rec., vol. 34, no. 28, July 14, 1920, pp. 668-669. As an example of unnecessary number of appliances, it is stated that 128 cities use 332 styles of corporation cocks where three patterns in seven sizes would answer.

[See also PUMPING STATIONS.]

WAVES

Stationary

Stationary Waves in Water, A. R. Richardson. Lond., Edinburgh and Dublin Philosophical Mag. & Jl. of Sci., vol. 40, no. 235, July, 1920, pp. 97-110, 6 figs. Some exact solutions are obtained, and existing results are linked together through a differential equation. Discusses, among other problems, that of flow over a weir and approximate calculation is made of constants which appear in Francis formula. It is shown that although problem of liquid under gravity with a free surface and given form of rigid boundary is very difficult of solution, yet main characteristics can be determined by noting form of free surface in such cases and using methods described.

WELDING

Eye Protection

Eye Protection in Welding Operations, R. R. Butler. Eng., vol. 109, no. 2842, June 18, 1920, pp. 823-826, 7 figs. Reasons why protection is needed for the eye and properties of glasses for protecting eyes from injurious radiations. Paper read before British Acetylene & Welding Assn.

High-Pressure Cylinders

Proposed French Regulations for High Pressure Cylinders. Welding Engr., vol. 5, no. 7, July 1920, pp. 34, 36, and 42. Proposed regulations for metallic containers for compressed, liquified and dissolved gases.

[See also ALUMINUM, Welding of; ELECTRIC WELDING; ELECTRIC WELDING, ARC; OXY-ACETYLENE WELDING.]

WELFARE WORK

Mines

Welfare Work at the Homestake Mine, B. C. Yates. Eng. and Min. Jl., vol. 110, no. 5, July 31, 1920, pp. 198-203, 7 figs. Avoidance of paternalism, a lively interest in clean amusement, and development of the community spirit, it is said, have been the guiding influences in shaping the human engineering plan followed by the Homestake Mining Co., Lead, S. D.

Shop Papers

Human Interest in the Employees' Magazine, John T. Bartlett, Indus. Management, vol. 60, no. 2, Aug. 1920, pp. 112-115. Editorial attitude to assume in shop papers. Examples of articles published in shop papers which have developed interest among employees.

Steel Industry

How Corporation Aids Workers, C. L. Close. Iron Trade Rev., vol. 66, no. 24, June 10, 1920, pp. 1685-1690, 5 figs. Welfare work, accident prevention, stock subscription for employees and pension funds have entailed expenditure of $71,651,731 since 1912. Multiplicity of interests of United States Steel Corp., described by department manager. Paper read before Am. Iron and Steel Inst.

Welfare Work in the Steel Industry—II, C. L. Close. Blast Furnace & Steel Plant, vol. 8, no. 8, Aug. 1920, pp. 462-465. Review of safety, sanitary and welfare bureau's work as it is carried on among employes of United States Steel Corporation and its subsidiary companies.

U. S. Steel Corporation

Financing Homes for Employees—II. Iron Trade Rev., vol. 67, no. 2, July 8, 1920, pp. 107-111, 5 figs. Steel Corporation's three alternative plans are: Corporation will build or buy and sell on small payments or on mortgage basis. How rights of both parties are safeguarded is explained.

WIRE DRAWING

Steel, Theory of

Steel Wire and Wire Drawing, E. A. Atkins. Eng., vol. 109, nos. 2839 and 2840. May 28 and June 4, 1920, pp. 731-734, 19 figs., and 749-752, 15 figs. Theory of wire drawing, with photomicrographs showing deformation of crystals during flow of steel and stress-strain diagrams of various alloy steels. Impurities in steel as they affect wiredrawing. Paper read before Liverpool Eng. Soc.

WOODWORKING INDUSTRY

Need of Engineering Skill in

The Engineer and the Woodworking Industy, Thomas D. Perry. Mech. Eng., vol. 42, no. 8, Aug. 1920, pp. 448-450, 3 figs. Scope of woodworking field is outlined and engineering problems involved are presented. It is said there exists an urgent need of engineering skill in woodworking industry.

X

X-RAYS

Soft

Note on Article by H. M. Dadourian on "Soft X-Rays," Elizabeth R. Laird. Physical Rev., vol. 15, no. 4, sec. series, Apr., 1920, pp. 293-296, 1 fig. Points out that unless field is fully symmetrical one kind of ions or of rays will get through and light is not thus trapped; use of secondary field renders uncertain value of supposed retarding field. Experiments are described exhibiting similar variations, the incorrectness of which is shown by comparison of photoelectric and ionization currents, and by observations with apparatus further denuded of gas. Discussion of use of term soft X-Rays.

Soft X-Rays Produced by Cathode Rays of from 200 to 600 Volts Velocities, Elizabeth R. Laird and Vola P. Barton. Physical Rev., vol. 15, no. 4, sec. series, Apr., 1920, pp. 297-308, 6 figs. New experiment is described showing difficulties in measuring a photoelectric effect due to soft X-Rays produced in same chamber as that which contains photoelectric electrode. Details of relative intensities and actual ionization current at 600 volts; intensity at 300 volts was less than 2 per cent of that at 600 volts. Tests show that effects thus far obtained were due to gas in tube and not to radiation from solid anticathode.

Spectrometric Research

Spectrometric Researches on X-Rays (Recherches spectrométriques sur les rayons X), M. A. Dauvillier. Anales de Physique, vol. 13, March-April, 1920, pp. 49-134, 22 figs. Studies cover; Observations with Bragg's spectrometer of X-Ray cathodic spectra; verification of absorption phenomena discovered by Barkla; oscillagraphic study of dischage in Coolidge tube; outline of principles of precise spectrometry; and theoretical and experimental investigation of effect of electronic density at focus.

Z

ZINC

Nickel Plating of

Nickel Plating Rolled Zinc. Metal Industry (New York), vol. 18, no. 7, July, 1920, p. 308. Methods recommended by New Jersey Zinc Co.

ZINC ALLOYS

Ziskon and Zisium

The Trade Origin of Two Valuable Alloys, R. E. Search. Metal Industry (N. Y.), vol. 18, no. 6, June, 1920, p. 269. Account of ziskon, composed of from three to four parts of zinc to one part of aluminum; and zisium, containing zinc, tin and copper with trace of antimony and which is said to be closely allied to magnalium used in manufacturing cane and umbrella handles.

ZINC MINING

Wisconsin District

Development Practice in the Wisconsin Zinc District, Edwin R. Shorey. Min. & Metallurgy, no. 164, Aug. 1920, pp. 22-23. Attention is directed specially to methods of sinking shafts. Sinking speeds average 15 to 20 ft. per week. (Abstract.)

Mechanical Engineering

A monthly journal containing a review of progress and attainment in mechanical engineering and related fields, The Engineering Index (of current engineering literature), and a summary of the activities, papers, and proceedings of

The American Society of Mechanical Engineers
29 West 39th Street, New York

VOLUME 42 NOVEMBER, 1920 NUMBER 11

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C 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Contributors and Contributions

Valuable Group of Research Papers

The important investigation reported in the paper entitled Constitution and Properties of Boiler Tubes was carried out because of defects which developed in tubes of the boilers of the Park Place plant of the Detroit Edison Company, requiring replacement of the defective tubes, and consequently shutting down the boilers, not infrequently when a heavy load was on the plant. In consequence an extended investigation of the causes of the defects and possible remedies was carried out by A. E. White, Consulting Metallurgist of the Detroit Edison Company and Professor of Chemical Engineering at the University of Michigan. Professor White's conclusions are of unusual interest to all engineers in the power-plant field.

A. E. White

Prof. W. L. DeBaufre, now at the University of Nebraska, and the author of the paper on the Calibration of Nozzles for Measuring Air Flowing into a Vacuum, was for a number of years one of the leading research engineers of the U. S. Naval Engineering Experiment Station at Annapolis, Md., While at the Experiment Station, he directed a long series of tests upon air pumps and condensers, during which it was desired to measure quantities of air by means of nozzles. This led to a separate investigation, which is reported in this paper.

In making service tests on bearings used in supporting worms in motor-truck rear axles, Kalman Heindlhofer gathered important information about the efficiencies of worm drives. Mr. Heindlhofer, for the past two years Research Engineer for the SKF Industries, Inc., has in this issue, presented this material under the heading, Tests on Rear-Axle Worm Drives for Trucks.

Effects of Fittings on Flow of Fluids through Pipe Lines is a paper containing data of great value in designing pipe lines. Dean E. Foster of Tulsa, Okla., the author of the paper, is a consulting engineer in the oil fields. In the absence of readily available data, Mr. Foster made a careful study of the known facts about pipe fittings, and the present paper, which is the result of his study, supplies tables and curves for the ready use of the engineer.

The results of a rather unusual and extensive investigation of the Heat-Insulating Valve of Cork and Lith Board are given by A. A. Potter, J. P. Calderwood, A. J. Mack and I. S. Hobbs. A. A. Potter is at present head of the department of Mechanical Engineering at Purdue University, but when the paper was prepared, was Dean of Engineering at Kansas State Agricultural College, where his co-authors are at present members of the faculty.

D. E. Foster

Experiences with Large Center-Crank Shafts

A painstaking investigation necessitated by the failure of a center-crank shaft for a large gas engine, is recorded by Louis Illmer in this issue. The stress diagrams and analysis of the effect of wear on the bearings will be of fundamental value to the designer of large machine parts.

Principles of the Gyro-Compass

The disturbing forces acting on the gyro-compass when on shipboard are discussed in a paper by George B. Crouse, at one time an engineer of the Sperry Gyroscope Co. Mr. Crouse explains the principle of the gyro-compass and considers the major design problems, namely, compensation of disturbing forces, methods of suspension, and methods of damping.

Standardization

The fields open to standardization and the possibilities resulting from it seem unlimited. In fact, advance in engineering depends upon it. With emphasis, therefore, attention is called to the matter in this issue relating to standardization progress. Space will be devoted each month to this important work of the various standardizing bodies.

Superpower

The word Superpower has caught the imaginations of engineers. The progress on the Superpower Survey and the preliminary steps leading to it are discussed editorially in this issue, from information furnished by W. S. Murray who is in charge of this important work.

Books for the Engineer

A new feature in this issue is the book review contributed by Director Craver of the Engineering Societies Library. The engineer must read, but to read all technical works in his field is impossible. Mr. Craver's column will be of great assistance in choosing the most helpful books.

1920 A.S.M.E. MEETING LOOMS LARGE

The Engineering Societies Building, New York, will be the scene of four days of interesting events December 7–10.

Tentative program will be found on page 647 of Section One of this issue.

40th ANNIVERSARY MEETINGS

Plans for big celebration on November 5 are explained in Section Two of Mechanical Engineering. Section Two also contains complete accounts of A.S.M.E. Affairs.

MECHANICAL ENGINEERING

Volume 42 November 1920 Number 11

The Constitution and Properties of Boiler Tubes

Causes Underlying Defective Tubes—Grain Growth under Temperatures below Critical Point a Factor—Higher Carbon Content Suggested

By ALBERT E. WHITE,[1] ANN ARBOR, MICH.

DURING the winters of 1913–1914 and 1914–1915 considerable difficulty was experienced by the Park Place Heating Plant of The Detroit Edison Company in maintaining continuity of boiler operation. This difficulty arose because of the frequent shutdowns necessitated when boiler tubes bore evidence of being or becoming defective, requiring in consequence the temporary closing down of the boiler or boilers until the tubes in question could be replaced. Tubes in the front bank of the boilers were particularly prone to develop defects, and since this condition was experienced in its most aggravating form at a time when the boilers were most needed, namely, during the various cold snaps of the winter, investigations were started so that suitable steps might be taken to combat the trouble.

The necessity for obtaining relief was emphasized in June 1915, when No. 7 tube in the third row of No. 7 boiler at the Park Place Heating Plant let go. The appearance of this tube after the accident is given in Fig. 1. This tube failure made necessary the rebuilding of most of the boiler, and especially the replacement of nearly all of the tubes in the boiler. Fortunately no injuries were sustained by any of the men in the plant. Also, the failure occurred at a time of the year when the plant was not operating at full load, so that the customers were not subjected to any inconvenience through lack of steam.

The accident, however, indicated the need for prompt relief and investigations were started along three lines: (*a*) water softening, (*b*) rearrangement of baffling, and (*c*) considerations relating to the composition and constitution of boiler tubes.

Water Softening

With reference to water softening, it was noted that practically all of the tubes which were replaced showed a thin but tough scale on the water side. This scale was calcium sulphate and was thin simply because the quantity of this salt in the boiler feedwater was relatively small and in plants operating under normal load conditions would have warranted no consideration. In these boilers, however, which were of the Stirling water-tube type of 750 hp., the long periods of cold often necessitated a load averaging 80 per cent above the nominal rating for periods extending at times into as many as six days. These load conditions, while not apparently unusually exacting, were in reality very severe when cognizance is taken of the fact that 98 per cent of the boiler feedwater was raw water drawn from the city mains.

There was no question but that the thin scale seriously affected heat transmission and was one of the contributing factors leading to tube failure. Much research work was done on this phase of the problem and it resulted in a decision to treat all of the water in the plant with soda ash. Since this treatment has been in use practically all of the insolubles are caught in the live-steam purifier. There is no scale in any of the tubes, although there are flocculent particles of insoluble sodium carbonate circulating with the water in the boilers. This product, together with the other minor insoluble ones that may be present and the soluble salts, especially sodium sulphate, are kept down to harmless percentages by frequent boiler blow-offs. The Dionic tester is used as a guide, experience indicating that when it reads under 1800 no fear need be had of trouble resulting from foaming and priming.

Changes in Baffling

Steps were also instituted with reference to a study of the baffling. At the time when the trouble was most pronounced, the front baffles were between the first and second rows of tubes. This arrangement had been adopted since it was believed that it would produce higher temperatures with consequent fuel economy and abatement of the smoke nuisance.

The investigations showed that most of the tube replacements were from the front row. For the purpose, therefore, of distributing the radiant heat among a greater number of tubes, hoping in this way to increase tube life without, however, carrying the same to such an extent as to decrease the fuel economy or run into the smoke troubles coming from incomplete combustion, the front baffling was changed so as to lie between the second and third rows rather than between the first and second rows. This arrangement has been most beneficial. There has been no decrease in fuel economy nor increase in smoke nuisance and tube replacements have been materially lowered.

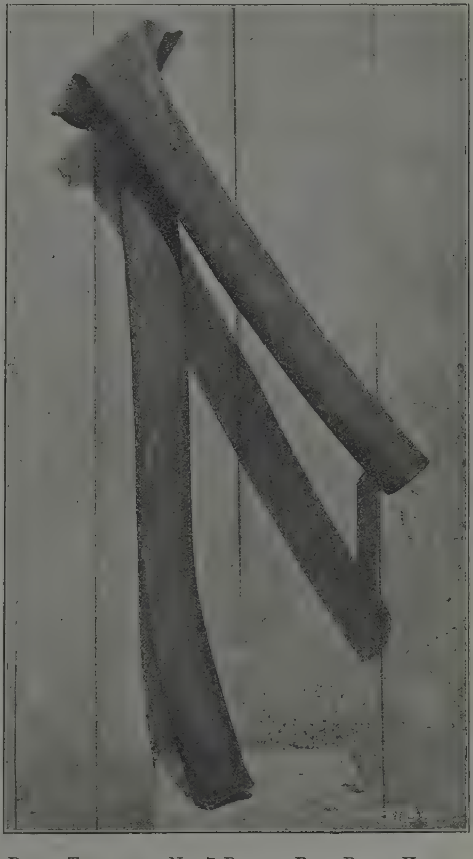

Fig. 1 Burst Tube from No. 7 Boiler, Park Place Heating Plant, Detroit Edison Company

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[1] Consulting Metallurgical Engineer, Professor of Chemical Engineering, University of Michigan.

Abstract of paper to be presented at the Annual Meeting, New York, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

Constitution of Tubes

Under the third line of investigation listed above—the composition and constitution of boiler tubes—the first step was a study of the constitution of the metal in the tubes. This was undertaken for the purpose of ascertaining the effect of service conditions upon the types of tubes now employed. The metal in a very considerable number of tubes was examined metallographically, the etching mediums being the common nitric acid and the so-called Rosenhain. This latter deposits copper over the surface of the metal, giving an even coating when the distribution of the metalloids is uniform; but when such is not the case, disclosing minutest segregations and imperfections most clearly by variations in the depth of the plating.

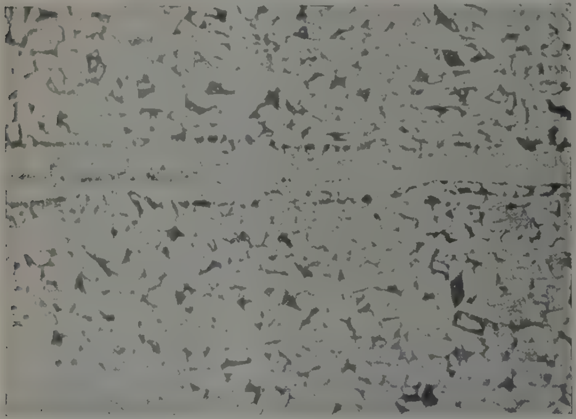


Fig. 2 Average Boiler-Tube Structure; Magnification 100; Etched with Nitric Acid

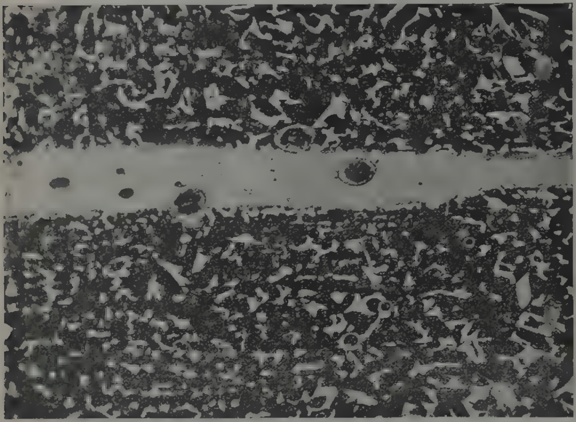


Fig. 3 Average Boiler-Tube Structure; Magnification 100; Rosenhain-Etched

Two photomicrographs showing the structure of a piece of boiler-tube metal which was selected as typical of the average of the majority of the sections examined, are shown in Figs. 2 and 3. The photomicrograph in Fig. 2 was taken after a sample had been etched in nitric acid, and in Fig. 3 treated with the Rosenhain reagent. It will be noted that the etching is uniformly distributed, indicating that the constituents are evenly dispersed throughout the metal. A clearly defined ghost line is brought out, resulting from phosphorus segregation, although more apparent in one resulting from the Rosenhain etching. There are also strikingly evident cavities or segregations which the writer has detected in many of the samples which he has examined. He considers this condition most serious and will further discuss it below. [In the pamphlet copy of the paper are other photomicrographs of samples representing the average of the best structure and of the poorest structure found among the different specimens.—Editor.]

Causes of Tube Failure

On the completion of this preliminary survey attention was directed to the causes of tube failure. Excluding that due to imperfect heat transmission resulting from scale, the writer believes that the principal causes can be listed under the following heads: .

a Failure due to tube brittleness resulting from absorption by the metal of hydrogen and usually attributable to faulty boiler-feedwater treatment

b Failure due to blowholes or other imperfections in the metal

c Failure due to recrystallization of the metal.

Tube Brittleness Resulting from Hydrogen Absorption. The first of these causes, namely, that due to tube brittleness resulting from the absorption by the metal of hydrogen, will not be developed in this paper. The facts are outstanding that contained hydrogen in metal makes it extremely brittle. The facts are further outstanding that certain types of water improperly treated, or all water excessively treated with certain types of boiler compounds, will cause the tubes to absorb hydrogen and become brittle. With intelligent treatment, however, there need be no cause for concern over tube failure from this source.

Failure from Blowholes. Failure from blowholes and other imperfections, the writer believes, should receive greater consideration in the future than has been accorded it in the past. The matter of course goes back to the steel mill and calls for greater emphasis on quality and less on tonnage.

A photomicrograph of a sample of metal containing blowholes is shown in Fig. 4. The ghost line is evident and even a casual scrutiny reveals radiating lines issuing from the center of the cavity. This condition is manifest in all of the photomicrographs taken of specimens with blowholes and indicates a lack of continuity of the metal. Should service conditions cause the tube to bag and should a cavity of the pipe shown in Fig. 2 be at the nipple of the bag, there is every reason to anticipate a bursting of the tube, with all of the attending dangers and expense.

Failure from Recrystallization. This matter merits much consideration. Recrystallization is accompanied by a marked decrease in the elastic limit and fatigue-resisting properties of the metal manifesting this phenomenon. It will occur if steel with a low carbon content which has previously been mechanically deformed at a temperature below the critical is later heated for a sufficient time to any temperature below that at the critical. The common composition for boiler tubes is such that this class of metal is especially susceptible to this phenomenon. Mechanical deformation to some degree is unfortunately assured by present-day methods of handling tubes, for at the mill tubes are straightened and in many cases actually brought to final size when below the critical temperature. Tubes are often bent during fabrication and erection and are universally rolled into the tube sheet when cold, and the methods of cleaning tubes in service often employ forms of apparatus which produce local deformation by repeated hammer

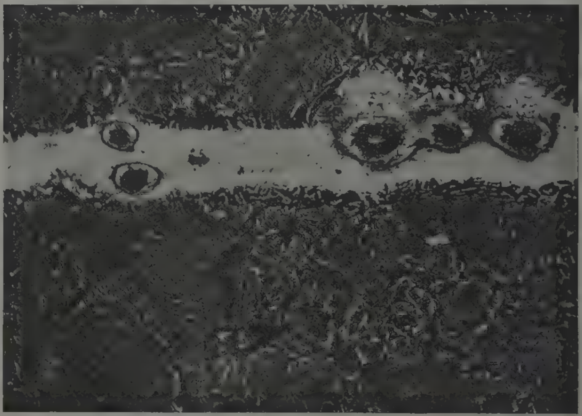


Fig. 4 Example of Blowhole, Prepared from Section of Boiler Tube; Magnification 100; Rosenhain-Etched

blows. Finally, the time and temperature conditions required for recrystallization are present.

Time-Temperature Criterion for Crystal Growth

Heating of deformed metal to temperatures approaching the critical, causes crystal growth in very short time periods. Corresponding growth occurs more slowly at lower temperatures, the time periods required for the same increasing very rapidly as the temperature to which the material is heated decreases. Values experimentally determined for temperatures from 550 deg. cent. (1022 deg. fahr.) to 675 deg. cent. (1247 deg. fahr.) for one set of conditions, are given by the following equations:

T (minutes) $= 8$ for 675 deg. cent. (1247 deg. fahr.)
T (minutes) $= 8 \times 3$ for 650 deg. cent. (1202 deg. fahr.)
T (minutes) $= 8 \times 3^2$ for 625 deg. cent. (1157 deg. fahr.)
T (minutes) $= 8 \times 3^3$ for 600 deg. cent. (1112 deg. fahr.)[1]

or, in general, for temperatures below 675 deg. cent. (1247 deg. fahr.)

$$T = 8 \times 3^n$$

where T = time in minutes
t = temperature in degrees centigrade
$n = (675 - t)/25$

That the normal method of handling boiler tubes results in mechanical deformation and that this metal as a result, under the proper conditions of time and temperature, will develop large crystals, is shown in Figs. 5 and 6. Fig. 5. is from a photomicrograph of a specimen of a tube which has been so deformed, and Fig. 6 from a specimen after receiving heat treatment at a temperature below the critical which quickly developed grain growth. A comparison of the grain sizes of the two samples indicates that the tube has been sufficiently deformed to respond to the laws of grain growth when the proper conditions for this development are present.

Physical Tests

Both tension tests and fatigue tests were made to determine the effect of coarse grains on the physical properties of the tubes. In each of the tension tests three samples per set were employed: the first on metal as received, the second on metal annealed for 10 minutes at 950 deg. cent. or 1742 deg. fahr. and then cooled in the furnace and the third on coarse-grained metal produced by stressing all of the test specimens the same amount and in all cases past the elastic limit and followed by an annealing for three hours at a temperature of 800 deg. cent. or 1472 deg. fahr. In the fatigue tests ten samples per set were used because of the greater difficulties in a test of this kind in securing check results.

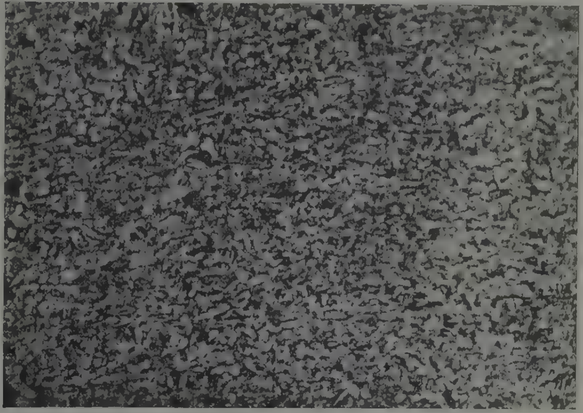
The physical properties of the "as received" samples showed satisfactory metal. The average tensile-strength and elastic-limit values of the "coarse-grain" samples were 27.2 and 58.9 per cent lower than they were for the "as received" samples and indicate, therefore, a decidedly inferior grade of metal. In the fatigue tests, also, the "coarse-grain" metal was 16.2 per cent poorer than the "as received," and 48.70 per cent poorer than the "annealed" metal.

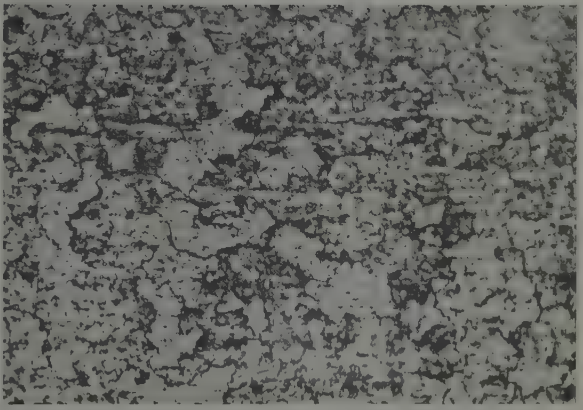
Composition of Tubes

In view of all of the conditions above pointedout there arose a question as to whether or not the present composition of boiler tubes, from the consumer's standpoint, was the most acceptable. Would there be a composition as easy to make from the producer's viewpoint, as easy to install, as resistant to the absorption of hydrogen, more strong, as free, if not freer, from blowholes, and above all less subject to recrystallization?

This is a formidable set of conditions, and yet do not tubes with a carbon content between 0.30 to 0.35 per cent more perfectly meet all of the above conditions than tubes with a carbon content ranging between 0.08 to 0.18 per cent?

Tubes with this higher carbon range will not be appreciably more difficult to manufacture or to install and there is nothing to indicate that they will absorb hydrogen more readily. It should be possible to make them as free of blowholes; there is no question but that they are at least 40 per cent stronger as measured by tensile-strength and elastic-limit tests throughout all working temperatures with no detrimental decrease in elongation or reduction; and finally, and most important of all, tubes with the higher carbon range are not subject to recrystallization.





Figs. 5 and 6 Effect of Heat Treatment on the Grain Size of Boiler Tubes; Sections Adjacent to Tube Sheet; Etched in Nitric Acid; Magnification 100; Fig. 5, Untreated; Fig. 6, Heated at 650 Deg. Cent. for 15 Hours

On this last point the literature is suggestive, although there have been no pieces of work as yet published as far as the writer knows which give direct proof.

In view of this condition, therefore, the following test was carried out to ascertain roughly the carbon range in which grain growth on deformed iron[1] when heated at temperatures below the critical range, occurred. Five irons were used with carbon varying from 0.006 to 0.315 per cent. Each of the samples was annealed so as to secure freedom from strains and obtain minimum grain size. This treatment was then followed by impressing a 5-mm. ball on each specimen under a load of 3000 kg. Each sample was then heated for four hours at 675 deg. cent. or 1247 deg. fahr., a temperature considerably below the critical for all of the carbon ranges present. The specimens were then examined and the average grain size in the section undeformed and in that portion of the deformed area showing maximum grain size compared.

The results given in Table 1 and shown in Fig. 7 indicate that iron in carbon ranges from 0.006 to 0.251 per cent, inclusive, undergoes a perceptible grain growth when treated as just described and that iron with a carbon content of 0.315 per cent is

(Continued on page 618)

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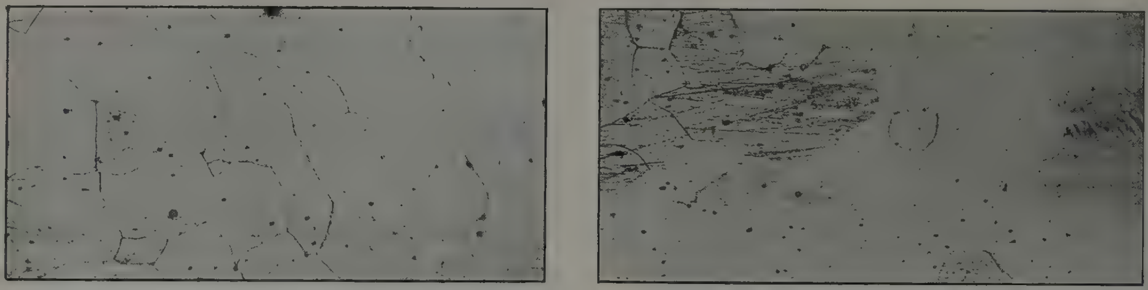
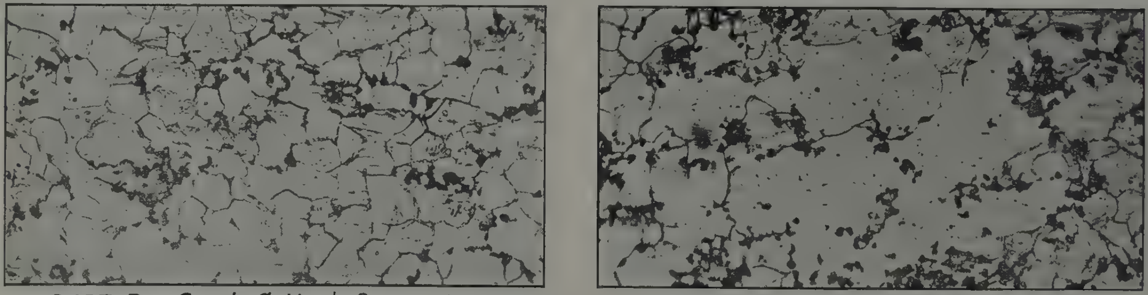
[1] Recrystallization as a Factor in the Failure of Boiler Tubes, White and Wood. Proc. American Society for Testing Materials, vol. xvi, pp. 82–116.

[1] The word "iron" is used in its generic sense and is intended to include steel and what is commonly called ingot iron.



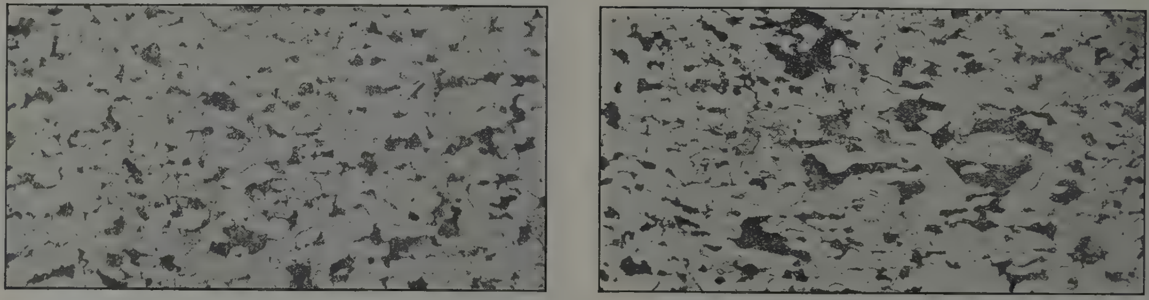
0.006 Per Cent C Undeformed

0.006 Per Cent C Deformed



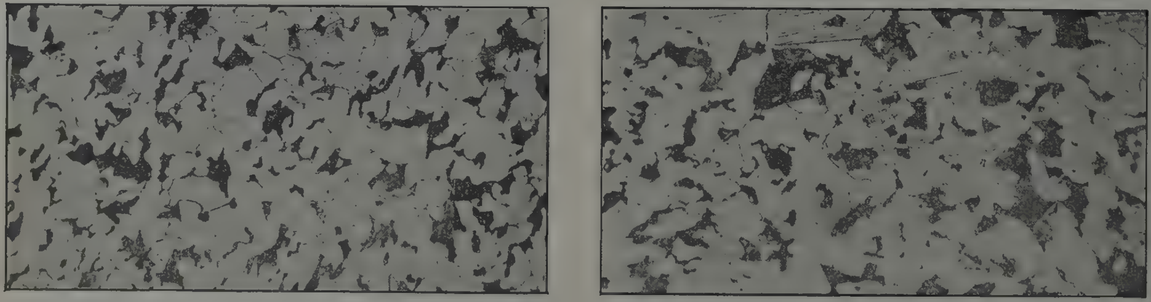
0.103 Per Cent C Undeformed

0.103 Per Cent C Deformed



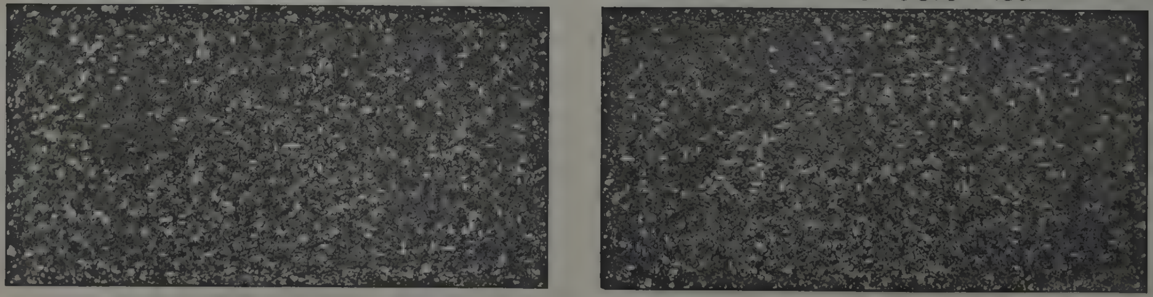
0.203 Per Cent C Undeformed

0.203 Per Cent C Deformed



0.251 Per Cent C Undeformed

0.251 Per Cent C Deformed



0.315 Per Cent C Undeformed

0.315 Per Cent C Deformed

Fig. 7 Effect of Carbon Content on Grain Growth in Deformed Iron When Heated Below Critical Temperature; Magnification 100; Etched in Nitric Acid. (Accompanying Article on Preceding Pages.)

Calibration of Nozzles for Measurement of Air Flowing into a Vacuum

By WM. L. DE BAUFRE,[1] LINCOLN, NEB.

The following paper is based upon an investigation of the flow of an elastic fluid through nozzles having well-rounded entrances, the effects of frictional resistance and of moisture in the atmosphere when the fluid is atmospheric air being taken into account. It is shown that the rate of flow of dry air decreases with increases of moisture, this result being based upon a series of tests on metal nozzles. The paper includes a description of the nozzles, the method of calibrating them, and the results obtained. Formulae employed in the calculations are also derived and the theory involved is outlined.

During some tests of air pumps, condensers, etc., conducted at the U. S. Naval Engineering Experiment Station, Annapolis, Md., it was desired to measure quantities of air by means of nozzles, the air flowing from the atmosphere through the nozzle into a vacuum. The problem was therefore to make a number of nozzles having orifices of suitable areas and to calibrate them, rather than to investigate correction factors for nozzles of different shapes. The following paper is based upon a report submitted on this work, and includes not only a description of the nozzles constructed, the method of calibration and the results obtained, but also the formulæ and calculations to be used. The complete paper from which this was abstracted contains a development of the formulæ and the theory involved.

Description of the Nozzles

Twenty monel-metal nozzle plugs were made of the general shape shown in Fig. 1-A. Monel metal was selected as it is practically non-corrodible and takes a high polish. The plugs were threaded with a 1-in. pipe thread, a standard ring thread gage being used to secure interchangeability. It was intended to use these plugs in a soft brass bushing as shown in Fig. 1-B in order to preserve the threads as long as possible. The threaded joint between plug and bushing was made tight with asphaltum.

Each plug was $1^1/_4$ in. long, and the 1-in. pipe thread permitted the use of a maximum diameter of 1 in. for the orifice through the plug. An entrance curve to the orifice was selected as shown in Fig. 1-C, constructed of two arcs approximating an ellipse. This entrance curve takes up three-tenths of the length of the nozzle, leaving in the case of the 1-in. orifice a straight portion seven-tenths of the nozzle length. The cross-section of all nozzles having orifices less than 1 in. in diameter are made geometrically similar to the 1-in. nozzle by counterboring the plug. In all nozzles, therefore, the length of the straight portion is seven-eighths its diameter, and the length of the entrance portion is three-eighths its diameter.

The diameters of the orifices were selected to correspond to standard drill sizes and to give convenient increments in area as given in Table 1. Except for the sizes below $^1/_4$ in., they were drilled $^1/_{32}$ in. smaller in diameter and reamed to size. The entrance surface was rubbed down with emery cloth to templet, giving the nozzle a highly polished appearance.

[Editor's Note: At this point in the complete paper the author discusses the theory of air flow through nozzles. He first develops equations for frictionless flow when no heat is imparted to or received from the flowing fluid by the nozzle. He next develops equations for flow which is not frictionless and shows that the coefficient of resistance depends upon the diameter and length of the nozzle, and for a given nozzle is therefore constant. He also shows that with a constant coefficient of resistance in the relation

$$p_1 v_1^n = p v_a^n$$

the exponent n can be taken as a constant and should evidently be the same for geometrically similar nozzles. The efficiency N of the nozzle he defines as the ratio of the kinetic energy actually possessed by the flowing mass to that theoretically available by adiabatic expansion through the same pressure range. The efficiency is therefore, dependent upon the ratio of expansion p/p_1 as well as upon the exponent of the expansion n. Equations are developed for calculating rates of flow for all possible values of the expansion ratio p/p_1. These equations take the form

$$\frac{G}{F} = \psi \sqrt{p_1 d_1}$$

in which G = rate of flow; F = area of orifice in sq. ft.; ψ = weight-flow factor; p_1 = initial pressure; and d_1 = initial density. The author also presents additional formulæ and curves for the calculation of the various terms.]

Description of Apparatus Used

The nozzle to be calibrated was screwed into a brass bushing mounted at N (see Fig. 2) in the side of the sheet-steel tank A. This tank was 8 ft. in diameter and 16 ft. high. A special cover or valve was arranged to close the nozzle. This valve, shown in open position in Fig. 3, consisted of a rubber-covered plate mounted on trunnions in a flat bar hinged at one end to the tank and having a handle at the other end. With the nozzle plug in place, the two screws at the back of the valve were adjusted so that its rubber-covered face fitted evenly over the face of the plug. The valve was held tightly closed by a hand nut screwed on a stud in the tank.

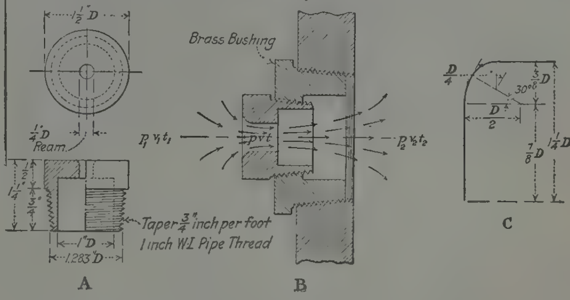


Fig. 1 Details of Nozzle Plugs

A, Cross-section of Nozzle; B, Method of Inserting Nozzle in Tank; C, Construction of Entrance Curve

TABLE 1 NOZZLE SIZES AND CAPACITIES

Nozzle Number	Drill Size	Diam. by Measurement, In.	Capacity, Lb. per Hr.	Capacity, Cu. Ft. per Min.
1	No. 46	0.08537	6.79	1.51
2	No. 33	0.11239	11.77	2.62
3	No. 21	0.15683	22.93	5.10
4	No. 9	0.19653	36.01	8.01
5	No. 1	0.22671	47.92	10.70
6	1/4 in.	0.24944	58.00	12.90
7	9/32 in.	0.27721	71.63	15.90
8	5/16 in.	0.31527	92.65	20.60
9	11/32 in.	0.34385	110.20	24.50
10	3/8 in.	0.37490	131.00	29.10
11	13/32 in.	0.40600	153.70	34.20
12	7/16 in.	0.43822	179.00	39.80
13	15/32 in.	0.46755	203.80	45.30
14	1/2 in.	0.49895	232.10	51.60
15	9/16 in.	0.56823	301.00	67.00
16	5/8 in.	0.61981	358.10	79.70
17	11/16 in.	0.68735	403.90	89.90
18	3/4 in.	0.74950	523.70	116.50
19	7/8 in.	0.87595	715.20	159.10
20	1 in.	0.99885	930.00	206.90

Note.—Capacity based on dry air at 70 deg. fahr. and with an initial pressure of 29.92 in. mercury and a final pressure less than 15 in. mercury.

The atmospheric pressure was indicated by a mercury barometer hung on a nearby wall, and the vacuum within the tank was measured by a mercury gage M (see Fig. 2). The latter was of the floating-scale type, consisting of a cast-iron float with a brass scale attached thereto. The float rises or falls with the mercury in the cistern so that the zero of the scale always corresponds with

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[1] Chairman M. E. Dept., Univ. of Neb., Mem Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

the surface of the mercury. The difference between atmospheric pressure and the absolute pressure in the tank was therefore obtained by a single reading—the height of the upper end of the column of mercury in the gage glass, obtained by means of a sliding index. Only one side of the column was used, it being of the duplex type. A thermometer was hung on the column to obtain its temperature.

The temperature within the tank was obtained from the resistance of a copper wire (No. 36 B. & S. Gage) strung from top to bottom of the tank six times and distributed across a diameter as shown at W in Fig. 4. This figure also shows diagrammatically the arrangement of the bridge used to measure the resistance of the wire W. The leads L_1 were of No. 12 copper wire, with compensating leads L_2 of the same size and length.

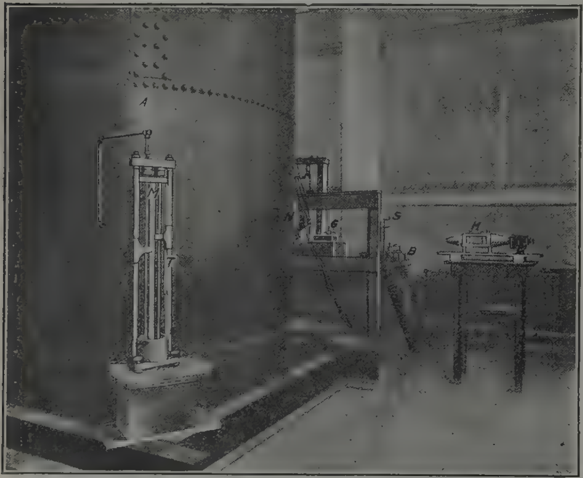

FIG. 2 APPARATUS USED FOR TESTS
A, Tank; M, Mercury Gage; N, Nozzle; H, Exhauster

The temperature and humidity of the atmospheric air flowing into the nozzle under calibration were determined from readings of dry- and wet-bulb thermometers placed in the suction duct of a small exhauster H (Fig. 2). The wet bulb was moistened by a cotton wick which dipped into one leg of a U-tube kept filled with water. By raising or lowering this U-tube, the cotton wick could be kept just sufficiently moist around the thermometer bulb, a drop of water occasionally falling from its lower end.

The evacuation of the tank was accomplished by a Westinghouse-Leblanc air ejector connected to the tank at D (Fig. 4). While the tank was being exhausted, valves C and D were open and valve E was closed. When the desired vacuum was attained, valves C and D were closed and valve E was opened to admit water from the vessel F to water-seal valve D.

METHOD OF CONDUCTING TESTS

The nozzle to be calibrated was first mounted in place, the valve adjusted to cover the nozzle squarely and the hand nut screwed down to hold the valve tightly closed. The tank was then exhausted by the ejector to a vacuum of 28 to 29 in. of mercury and the intervening valves closed and water-sealed. The tank was then allowed to stand overnight in this exhausted condition in order to insure that a portion of the water previously put into the tank would have time to evaporate and saturate the interior space. It was found necessary to add water in order to replace the moisture withdrawn with the air by the ejector; and if sufficient time were not allowed for the water to evaporate, the vapor pressure taken from steam tables to correspond to the temperature within the tank would be greater than the actual existing pressure, thus indicating that the space was not saturated with water vapor.

In order to obtain some idea of the weight of water required to be put into the tank, a curve was derived to give the actual volume of air removed at a continuously decreasing pressure according to the relation

$$\frac{v_r}{v_1} = \log_e \frac{p_1}{p_2} \quad \text{[1]}$$

in which v_r = total volume of air removed
v_1 = volume of tank
p_1 = initial pressure in tank
p_2 = final pressure in tank.

The application of this formula may be shown by an example. Thus, if the tank is exhausted from an atmospheric pressure of 30 in. mercury to a vacuum of 29 in. mercury, we shall have

$$\frac{p}{p_1} = \frac{30}{30-29} = 30$$

and from the formula or curve

$$\frac{v_r}{v_1} = 3.41.$$

The volume of the tank as determined by calibration with water was about 865 cu. ft. Hence

$$v_r = 3.41 \times 865 = 2950 \text{ cu. ft.}$$

This will also be the volume of the water vapor removed; and assuming it to be saturated steam at a temperature of 70 deg. fahr., with a corresponding density of 0.001148 lb. per cu. ft. (taken from steam tables), we find 3.4 lb. are withdrawn. Accordingly, about 5 lb. of water was put in the tank before exhausting each time.

Allowing the exhausted tank to stand overnight did not always insure saturation, and before taking readings the nozzle was opened to admit atmospheric air until the absolute pressure within tank doubled; that is, the vacuum dropped from say 29 to 28 in. mercury. The moisture brought in from the atmosphere together with the vapor in the tank insured saturation.

Each calibration run, during which the air nozzle under calibration was open, was preceded and followed by a leakage period. During the initial leakage period, readings of the barometric pressure, the vacuum within the tank, and the temperature within the tank were taken at intervals of 3 min. for a duration of 30 min. Then the nozzle was quickly opened at a given second to start the run and readings of the barometer, mercury column and wet- and dry-bulb thermometers taken at intervals of 30 sec. The run was ended by quickly closing the nozzle a certain number of

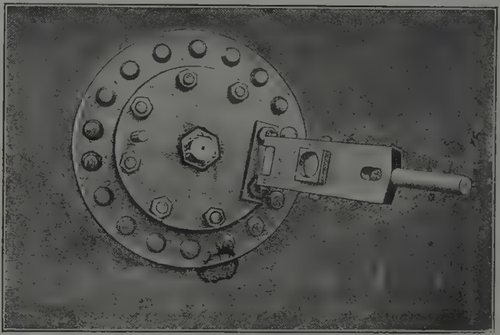

FIG. 3 SPECIAL VALVE FOR CLOSING NOZZLE

TABLE 2 SUMMARY OF RESULTS

Nozzle Number	Nozzle Diam. In.	Number of Runs	Average Weight-Flow Factor	Average Expansion Exponent	Average Weight-Flow Efficiency Per cent
1	0.08537	9	3.646	1.349	93.86
2	0.11239	6	3.786	1.378	97.48
3	0.15683	12	3.770	1.375	97.08
4	0.19653	4	3.824	1.387	98.46
5	0.22671	5	3.853	1.393	99.20
6	0.24944	2	3.768	1.375	97.02
7	0.27721	4	3.834	1.389	98.72
8	0.31527	2	3.748	1.370	96.49
9	0.34385	4	3.791	1.380	97.61
10	0.37490	2	3.776	1.376	97.22
11	0.40600	2	3.779	1.377	97.28
12	0.43822	4	3.767	1.374	96.98
13	0.46755	2	3.774	1.376	97.16
14	0.49895	2	3.781	1.377	97.35
15	0.56823	2	3.759	1.373	96.77
16	0.61961	2	3.831	1.388	98.64
17	0.68735	2	3.791	1.379	97.61
18	0.74950	1	3.636	1.346	93.61
19	0.87595	1	3.790	1.379	97.58
20	0.99885	1	3.728	1.366	95.98

minutes after opening it, the length of the run depending upon the size of the nozzle. A short run was necessary with the larger nozzles in order to prevent the pressure within the tank rising above the critical value. The final leakage period began at the time the nozzle was closed and continued for 30 min.

TABLE 3 VALUES OF WEIGHT-FLOW FACTOR FOR VARIOUS UNITS

Weight Flow G	Orifice Area F	Initial Pressure p	Initial Density d	Numerical Value of Factor ψ
lb. per sec.	sq. ft.	lb. per sq. ft.	lb. per cu. ft.	3.771
lb. per sec.	sq. in.	lb. per sq. in.	lb. per cu. ft.	0.3143
lb. per sec.	sq. in.	inches mercury	lb. per cu. ft.	0.2203
lb. per hr.	sq. ft.	lb. per sq. ft.	lb. per cu. ft.	13,576
lb. per hr.	sq. in.	lb. per sq. in.	lb. per cu. ft.	1,131.3
lb. per hr.	sq. in.	inches mercury	lb. per cu. ft.	792.9
kg. per hr.	sq. cm.	mm. mercury	kg. per cu. m.	11.061

TABLE 4 VALUES OF WEIGHT-FLOW FACTOR FOR VARIOUS UNITS

Weight Flow G	Orifice Area F	Initial Pressure p	Initial Temperature t	Numerical Value of Factor ψ
lb. per sec.	sq. ft.	lb. per sq. ft.	deg. fahr.	3.771
lb. per sec.	sq. in.	lb. per sq. in.	deg. fahr.	3.771
lb. per sec.	sq. in.	inches mercury	deg. fahr.	1.852
lb. per hr.	sq. ft.	lb. per sq. ft.	deg. fahr.	13,576
lb. per hr.	sq. in.	lb. per sq. in.	deg. fahr.	13,576
lb. per hr.	sq. in.	inches mercury	deg. fahr.	6,668
kg. per hr.	sq. cm.	mm. mercury	deg. cent.	18.458

Calculation of Results

The details of the method employed in correcting the data and deducing the results are illustrated and explained in the Appendix of the complete paper for Run 1 of Nozzle 1. To obtain the dry-air density in the tank the temperature and pressure observations for the leakage intervals preceding and following each run were plotted as shown in Fig. 5 and the calculations based on the curves rather than directly upon the observations. A curve was also plotted of weight-flow factor ψ to expansion exponent n so as to enable item 25 being obtained from item 24, and in Table 2 there have been tabulated for each nozzle the average values of the weight-flow factor, the expansion exponent, and the weight-flow efficiency. The number of runs made on each nozzle is also given. It will be noted that the calculations were based upon the pressure and temperature within the tank before the nozzle was opened and after it was closed, when the conditions were static, rather than upon the pressure and temperature, while the air was flowing into the tank.

Assuming all the individual runs to be of equal weight in applying the formula for the probable error of the mean value, we obtain the expansion exponent $n = 1.3747 \pm 0.0013$, and assuming the average values in Table 2 for the several nozzles to be of equal weight, we obtain $n = 1.3753 \pm 0.0018$. The probable error for a single run and for a single nozzle are, respectively, ± 0.0107 and ± 0.0078. That is, for carefully made nozzles geometrically similar to those tested, the value of n will probably be within 0.010 of 1.375 if the observations are taken as carefully as during this calibration test. The corresponding value and accuracy of the weight-flow efficiency are 97.1 ± 1.2 per cent.

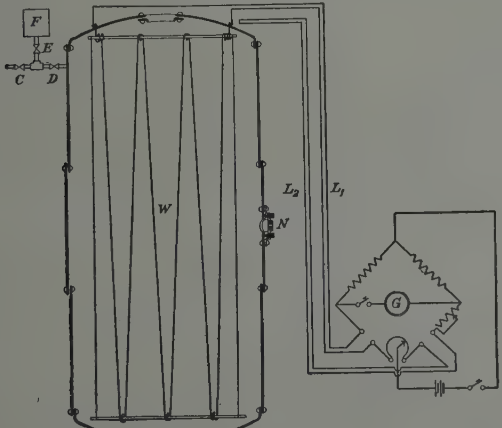

Fig. 4 Diagram Showing Method Employed to Measure Temperature within Tank

Corresponding to the expansion exponent $n = 1.375$, the numerical value of the weight-flow factor ψ in the formula

$$\frac{G}{F} = \psi\sqrt{pd}$$

will depend upon the units in which the several quantities G, F, p and d are expressed, as indicated in Table 3.

For final pressures greater than the critical pressure, that is, p/p_1 greater than 0.533, the factor will be reduced as given by the solid curve Fig. 6, for the units in the sixth line of Table 3.

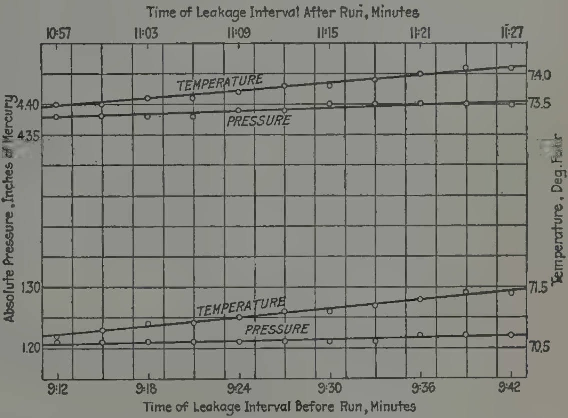

Fig. 5 Curves Showing Absolute Pressure and Temperature for Leakage Intervals Both Before and After Run No. 1 on Nozzle No. 1

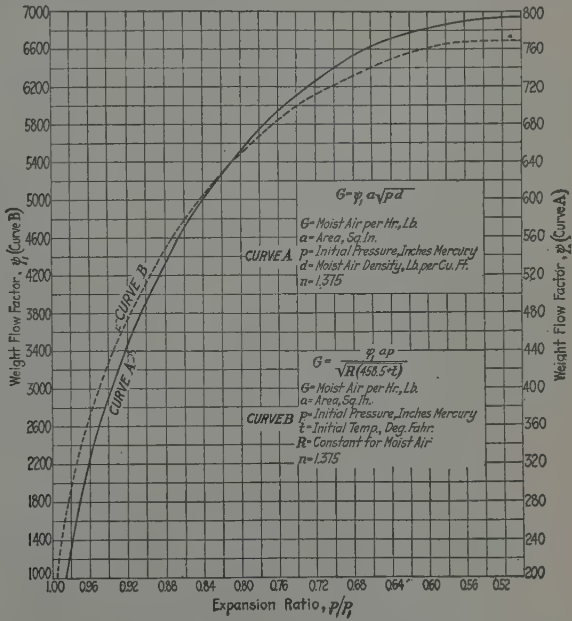

Fig. 6 Curves of Weight-Flow Factor with Expansion Ratio for $n = 1.375$

Changing the above formula into the form

$$\frac{G}{F} = \frac{\psi}{\sqrt{R}} \frac{p}{\sqrt{458.5 + t}}$$

also changes in certain cases the numerical value of ψ for the same units of G, F, p and t, as shown in Table 4.

For pressure ratios greater than 0.533, the dotted curve in Fig. 6 gives the reduced values of ψ corresponding to the units in the sixth line of Table 4.

The value of the constant R depends upon the ratio of water vapor to dry air in the fluid flowing through the nozzle and the

(Continued on page 650)

Experiences with Large Center-Crank Shafts

By LOUIS ILLMER,[1] PHILADELPHIA, PA.

This paper is descriptive of some disastrous experiences with a number of large gas-engine shafts of the center-crank type. The shafts were mounted upon three-point bearing supports and carried a heavy flywheel between the intermediate and outboard bearings. The stress diagrams show that this mode of support is likely to set up a pernicious interaction of bearing load, culminating in excessive wear in the intermediate main bearing.

When the wheel shaft lacks adequate stiffness, the appreciable lifting action at the free end of the web portion of a center-crank shaft may exert a considerable thrust against the cap of the aligned outer main bearing, which in turn reacts upon the intermediate journal, causing it to become overloaded. The resulting rapid wear in the intermediate main bearing reduces the upward cap thrust and this drop in alignment gradually relieves the intermediate bearing of overload. Further wear causes a portion of the downward load on the intermediate bearing to be transferred to the outer main bearing. It was found that when this readjustment is complete, the downward load upon the two main bearings becomes approximately equalized. The considerable sag required to attain this state of equilibrium as to wear, involved running under stress conditions so severe as to lead to ultimate breakdown of the wheel shaft.

In order to keep the wheel-shaft stress within desired limits under load conditions found in these engines, it finally became necessary to enlarge the intermediate main journal to $^{3}/_{2}$ *of its original diameter, thus making its dimensions fully as large as required for side-crank construction. It was found to be expedient to make a careful analysis of the underlying stress conditions so as to insure a proper margin of safety in both the web and wheel parts after allowing for the lengthening of the span between the wheel supports due to excess wear in the intermediate main bearing.*

SEVERAL years ago a series of disastrous center-crank shaft failures occurred in a 1200-kw. gas-power plant which the author investigated and in which he found that the wheel shafts were entirely too light for the load they had to carry.

The gas-power plant comprised three 25-in. by 43-in. 500-b.hp. double-acting producer-gas engine units, each driving a 400-kw. 25-cycle three-phase alternator at 100 r.p.m. The engines were of the direct-connected horizontal type, provided with a massive flywheel. The shafts were of the single-throw center-crank type, as indicated in Fig. 1, having a tensile strength of about 65,000 lb. per sq. in.

After being in 24-hour-a-day service for some four or five years, one of the shafts unexpectedly gave way near the flywheel hub, allowing the armature to drop and thus completely wreck its generator and heavy wheel, and in other ways doing serious damage.

In order that the cause of this and similar shaft failures might be intelligently arrived at, a series of sag determinations was conducted on the wheel shaft and a thorough technical investigation made of the underlying stress conditions.

The three-point shaft support for the heavy flywheel was found to set up a pernicious interaction of load which led to excessive wear in the intermediate main bearing. This resulted in the lengthening of the effective shaft span, which in turn produced sag stresses of such magnitude as to cause ultimate rupture of the shaft.

The inadequacy of a center-crank shaft for carrying a heavy wheel is made evident in the accompanying deflection diagrams. An excessive wheel-shaft deflection puts a large upward thrust against the outermost main bearing cap. The reaction of this thrust upon the intermediate main bearing may become so large as to squeeze the babbitt lining out of the bearing shell, in which event the resulting drop in this vital support allows the shaft to run with an excessive sag between the outermost main bearing and the outboard bearing. Thus the shaft stresses may be increased far beyond those usually anticipated by the engine builder, and if allowed to continue can readily cause the metal of this shaft to undergo such rapid fatigue as to lead to shaft rupture.

The matters of fixed stress limits and requisite factor of safety underlying good shaft design are rather fully discussed in the Appendix accompanying the complete paper.

Crankshaft Stress Diagrams

The shaft outline and load conditions under which the original shafts operated are shown in Fig. 1, in which the line *A-A* indicates the location of the wheel-shaft failure, its relative position being almost identical in three of these shafts. The journal portion of the shaft was carried straight up to the wheel hub but as indicated by the dotted outline in Fig. 1, it was entirely feasible to enlarge the shaft immediately after clearing the camshaft gear. Had this been done originally, it would have obviated the worst of the peak stresses shown in the diagram.

The original shafts were excessively loaded by a massive flywheel weighing about 73,000 lb., and by an armature of about 13,000 lb., to which should be added an assumed magnetic pull of about 10,000 lb., on the basis of $^{1}/_{32}$ in. armature displacement. The location of those weights is shown in Fig. 1, and their relative magnitude is indicated by varying line lengths, extending downward.

In making a preliminary stress analysis, in the conventional manner, it may be assumed that the wheel shaft is pin-supported between the intermediate main bearing I and the outboard bearing III. The resultant wheel-shaft load $P_r = 96,000$ lb., acting downward, causes the shaft to deflect, thus putting the bottom fibers in tension and the top fibers in compression. The rotation of the shaft sets up a reversal of stress with each revolution.

In addition to these alternating stresses, the shaft is subject to a negligible shear stress due principally to the weight of the wheel. In a horizontal engine the effect of the connecting-rod thrust in producing an increase in the wheel-shaft stress may be sufficiently allowed for by taking into account only the twisting stress resulting from the transmission of power to the generator.

The effect of this twisting action may best be combined with the bending moment as indicated in the stress curve in Fig. 1. It will be seen that while the original wheel-shaft strength lacks uniformity, the maximum stress estimated on this preliminary basis reaches a peak value of only about 10,000 lb. per sq. in. near the point of rupture.

Assuming the wheel to be perfectly balanced and the shaft to run true, the basic or net factor of safety for this shaft, as determined by the Appendix, appears to be equal to about 2.2, as against a minimum stipulated factor of three. It is evident that this minor difference is insufficient to account for the wheel-shaft failure, but the diagram does show that this conventional mode of checking center-crank wheel-shaft stresses cannot be relied upon to bring out the cause of rupture.

Effect of Three-Point Shaft Support

In order to arrive at the cause of the present shaft failure, it is necessary to take into account the interacting effect of the three-point shaft support. Assuming all the bearings to be in perfect alignment, it will then be found that the excessive wheel-shaft deflection produced by the massive flywheel, puts a 20,000-lb. upward thrust against the cap of the outermost main bearing II, which in turn reacts upon and so overloads the intermediate bearing as to squeeze out its babbitt. As indicated in Fig. 2, the drop in this vital support causes sag stresses to be set up that more than double the peak stress previously determined by the preliminary stress check represented in Fig. 1.

The estimated stress relations shown in Fig. 1 assume the original wheel shaft to be pin-supported between bearings I and III only, a condition that is approximated when the cap is removed from the outer main bearing II.

The cap thrust of 20,000 lb. reacts to effect an increase in the downward load of the intermediate bearing. With the cap II forced into place under conditions of perfect alignment, the resultant downward pressure in the main bearing I is approximately 400 lb. per sq. in., and if to this the downward centrifugal force is added, a maximum pressure of about 500 lb. per sq. in. of net pro-

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jected area is reached. Such a heavy bearing pressure fails to distribute uniformly and the consequence of excessive loading is to squeeze the babbitt out of the intermediate shell. The resulting rapid wear serves to relieve the intermediate bearing of its overload by lowering its alignment with respect to the end supports of the shaft.

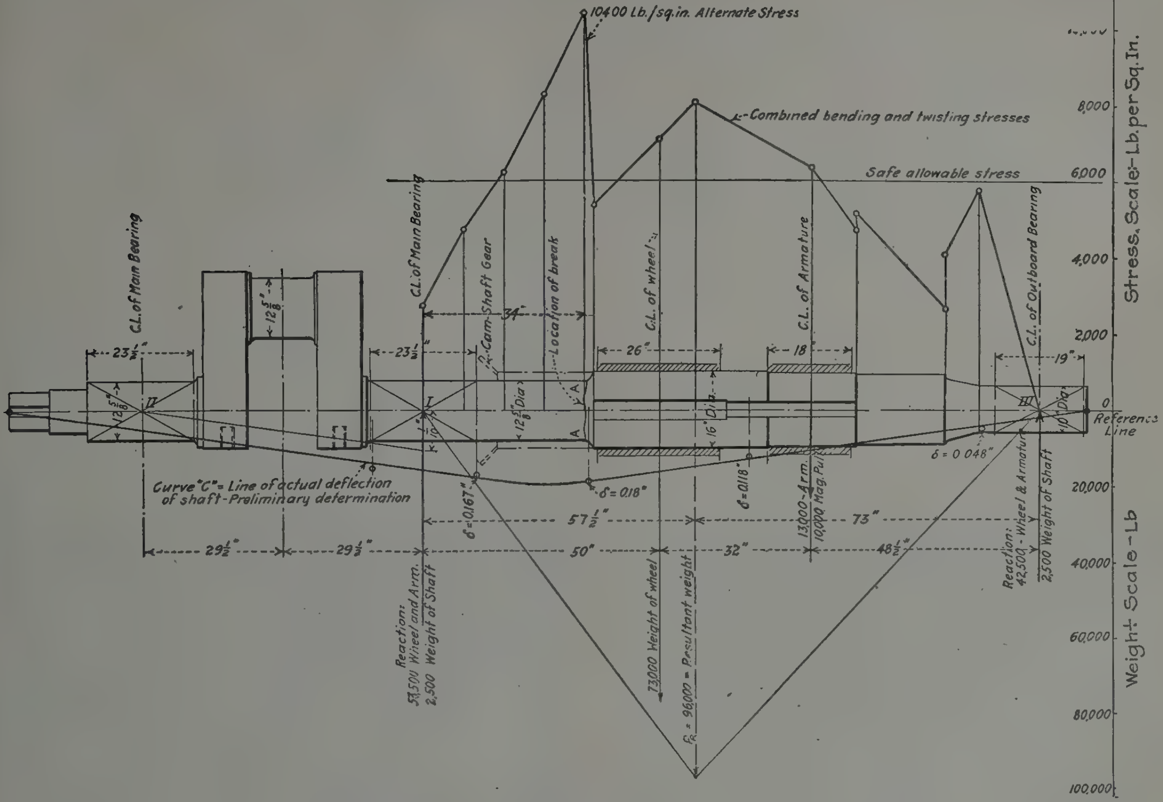

Fig. 1 Preliminary Stress Diagram for Pin-Supported Wheel Shaft

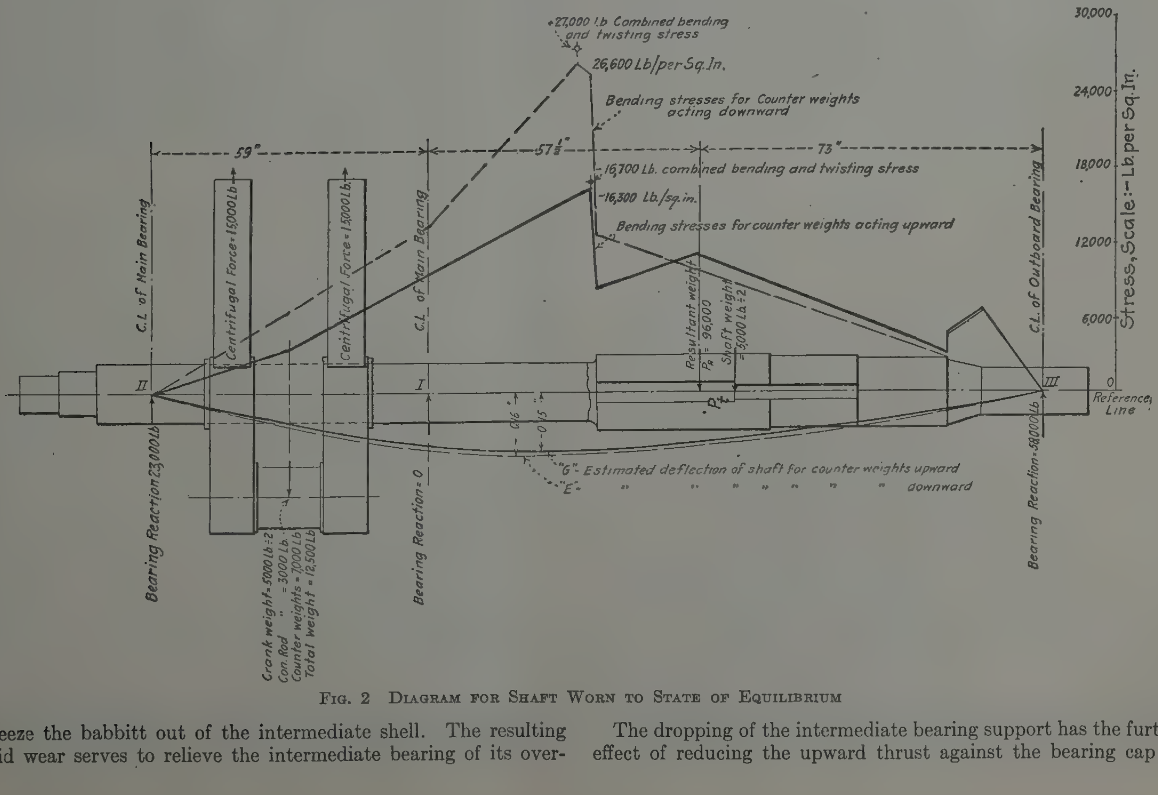
27,000 Lb Combined bending and twisting stress
26,600 Lb/per Sq. In.
Bending stresses for Counter weights acting downward
16,700 Lb. combined bending and twisting stress
16,300 Lb./sq.in.
Bending stresses for counter weights acting upward
59"
57½"
73"
C.L. of Main Bearing
Centrifugal Force = 15,000 Lb
Centrifugal Force = 15,000 Lb.
C.L. of Main Bearing
Resultant weight Pr = 96,000
Shaft weight = 5,000 Lb ÷ 2
C.L. of Outboard Bearing
II
I
III
Pr
0.16"
0.15"
"G" - Estimated deflection of shaft for counter weights upward
"E" - " " " " " " downward
Bearing Reaction 23,000 Lb
Crank weight = 5000 Lb ÷ 2
Con. Rod " = 3000 Lb.
Counter weights = 7000 Lb
Total weight = 12,500 Lb
Bearing Reaction = 0
Bearing Reaction = 58,000 Lb
Reference Line
0
6,000
12,000
18,000
24,000
30,000
Stress, Scale:- Lb. per Sq. In.

Fig. 2 Diagram for Shaft Worn to State of Equilibrium

The dropping of the intermediate bearing support has the further effect of reducing the upward thrust against the bearing cap II, and as the downward forces undergo readjustment by continued wear, the outer main bearing II will gradually assume an increased portion of the downward shaft load. Experience shows that when the load upon each of the main bearings becomes approximately equal, a condition of stable equilibrium will have been established, after which the two main bearings continue to wear down together at a more or less uniform rate.

In order to attain such a state of equilibrium, the shafts must suffer undue deflection as indicated in Fig. 2. Experience further shows that when starting with newly aligned bearings this condition is reached in a remarkably short time, being approximately 30 days of continuous operation under the existing load conditions. The corresponding wear in the intermediate bearing was found to be about $^1/_8$ in. in this brief period, as against a normal wear of say $^1/_{64}$ in. to $^1/_{32}$ in. per year for continuous running.

Fig. 2 also shows the marked effect which the dropping of the intermediate bearing support has in enlarging the effective shaft span and thus largely increasing the bending stresses.

These high sag stresses have been checked by comparing the estimated deflection curve E with the actual wheel-shaft sag as taken off one of the original shafts. The deflections were determined by means of a pin gage and these measurements were corrected for the sag of the reference cord. Thus the actual shaft sag, measured at the center of the intermediate main bearing, was found to be about 0.16 in. lower than the end supports, as against an estimated value of about 0.14 in.

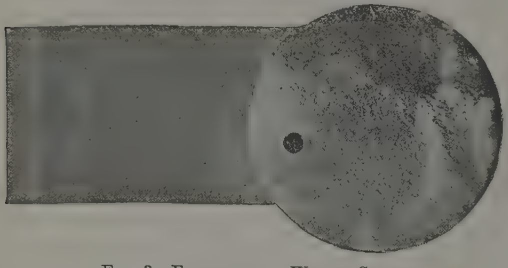

FIG. 3 FRACTURE OF WHEEL SHAFT

The calculations show further that after reaching the aforesaid state of equilibrium, the estimated maximum pressure acting in the main intermediate bearing is reduced to about 218 lb. per sq. in. of projected area, which can readily be sustained without excessive wear. Under these conditions the shaft suffers a maximum bending stress of about 26,600 lb. per sq. in., and it is found that this peak practically coincides with the point of rupture. This extremely high stress is still further increased when combined with the crank twisting stress.

DETRIMENTAL EFFECT OF HEAVY COUNTERWEIGHTS

The massive counterweights with which these engines were provided were designed to balance the inertia effects of the heavy reciprocating parts, averaging about 115 lb. per sq. in. of piston area. When the centrifugal force acts upward, a maximum bending stress of 16,300 lb. per sq. in. results, while for downward action the bending stress is increased to about 26,600 lb. per sq. in. Combining these high stresses with the maximum twisting stress without allowing for shock or preignition, an equivalent maximum tension stress of 27,000 lb. per sq. in. is produced in the outer shaft fiber, and when this same fiber turns through 180 deg., it is subjected to a compressive stress of about 16,700 lb. per sq. in.

The corresponding ratio of $f_{\text{min.}}$ to $f_{\text{max.}}$ for this partially reversing stress is about 0.62 as defined in the Appendix, and the total stress range that this surface fiber undergoes during each revolution is about 43,700 lb. per sq. in., a limit far in excess of that which the metal can continuously endure. Checking this result on the basis of the formulæ given in the Appendix, the allowable stress range for unit basic factor of safety for 65,000-lb. T.S. steel is about 39,000 lb. per sq. in., which corresponds to a tension stress limit of about $f_{\text{max.}} = 24{,}000$ lb. per sq. in. The net or basic factor of safety in the original wheel shaft is thus found to be about 0.9, i.e., less than unity, for which the corresponding excess tension stress becomes equal to about $f_{\text{exc.}} = 27{,}000 - 24{,}000 = 3{,}000$ lb. per sq. in.

No record has been kept as to the running time actually required to rupture the original shafts, but judging from the average period of operation of these engines, it is probable that each of the defective shafts made between 100,000,000 and 150,000,000 revolutions prior to failure.

As based upon Stromeyer's fatigue formula as given in the Appendix, the excess stress $f_{\text{exc.}}$ required to produce rupture in the stated number of revolutions would lie between 2700 and 3000 lb. per sq. in. for an alternating-stress cycle. Accordingly, it would appear that the stress curves shown in Fig. 2 have been closely estimated and that the original shafts must have been subjected to a maximum tension stress approaching the elastic limit of the shaft material.

The character of the ruptured section of these shafts is shown in Fig. 3. The high alternating stresses set up in the outermost fibers undoubtedly produced gradual fatigue, which led to a rupture of the surface metal. This irreparable damage greatly weakened the shaft, and as the rupture crept inward, a point was finally reached where the shaft could no longer bear its load.

The fact that three of the original shafts became defective in practically the same place and that each shaft proved serviceable for a period approximating three years virtually precludes a defect in forging but points rather to improper shaft design as the cause of the mishap. In fact, it now appears that the ultimate failure could have been foretold had the underlying stress relations been analyzed in the manner advocated before deciding upon the final shaft dimensions.

Transporting Freight in Interchangeable Containers

A long step toward relieving the tense situation in the transportation lines of the country appears to have been made by the River and Rail Transportation Company of St. Louis, Mo. This company has developed an interchangeable metal container, termed "Trinity Freight Unit," for facilitating the transfer of goods at terminals. *Railway Age* for September 24 describes this container system of freight transportation. Merchandise is placed in the container at a manufacturing plant or in a warehouse and then, locked and sealed, the container is transported by motor truck to a railroad, or to a waterway, where it is transferred to a flat car or to a boat without rehandling the materials.

The complete unit includes a specially constructed flat car, which differs from those now in use on the railroads of the United States only in providing a means of clamping the containers fast to the platform of the car. Estimates, based on present prices, place the cost of equipping a car with five 10-ton units at $1000. A flat car having these special features may be built for the same cost as that required for an ordinary flat car, or existing flat cars may be altered to carry the containers at an approximate cost of $250.

Containers made in a number of different ways are provided for carrying various kinds of material. A type is designed with side-opening doors for package freight, another with top doors and drop bottom for loose bulk freight, and there are other types for refrigerator service and for carrying liquids.

The units are made in capacities of $2^1/_2$ tons and 10 tons each and are proportioned so that five 10-ton units, or twenty $2^1/_2$-ton units, or several units of both capacities, and for any of the different classes of freight, can be carried on a flat car of 50 tons capacity. They are rectangular in form and are substantially constructed of steel plate rigidly reinforced with angle irons to withstand the strains due to the weight of the contents and the transferring of the unit from one vehicle to another.

The system has already been tried and proved successful. The United States Railroad Administration adopted it to facilitate water-rail shipments of war supplies. Twenty of the 10-ton package units were built and gave satisfactory service in the New Orleans district in handling package freight. Estimates based on the performance of these units indicate that the handling of freight is not only greatly expedited but can be handled at from 300 to 400 per cent less cost than with any of the present methods.

Tests on Rear-Axle Worm Drives for Trucks

By KALMAN HEINDLHOFER,[1] PHILADELPHIA, PA.

In this article is recorded a series of tests on worm drives used in the rear axles of motor trucks to determine the efficiencies under load variations. Efficiency curves showing results with four sets of gears in mesh are included. The effect of the oil temperature in the worm thrust bearing, on the efficiency of the drive is shown, higher efficiencies being derived at higher oil temperatures. The author also presents the record of life of four case-hardened steel worms that failed under load.

THE various tests on rear-axle worm drives which are to be described were conducted by the author during an investigation of ball-bearing applications. Important data and information were obtained concerning the efficiency of two axles of the same capacity and similar design, the temperature of the worm thrust bearings under full-load conditions, and the life of four worms which broke under load. The testing method employed was that developed by Prof. C. M. Allen and F. W. Roys and described in their paper Efficiency of Gear Drives.[2]

Figs. 1 and 2 show the test arrangement, which is represented diagrammatically in Fig. 3. The worm gears to be tested were mounted in a rear-axle housing and driven by an electric induction motor running 1200 r.p.m. under no load and 1160 r.p.m. under full load. It was possible to change the speed by a transmission having gear ratios of 5.93 : 1, 3.24 : 1, 1.74 : 1 and 1 : 1. The power transmitted was absorbed by an Alden dynamometer, which offered a very smooth and readily adjustable torque resistance. To avoid losses in the differential and the use of an extra dynamometer, the differential was locked. At each end the frame of the driving motor was supported by three disk rollers, which allowed the housing to swing on its supports without friction.

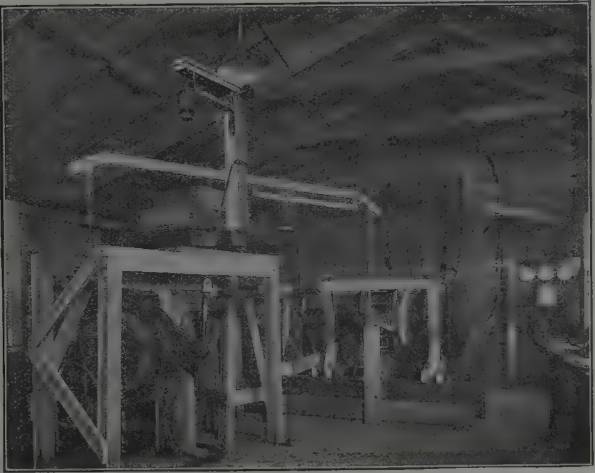

Fig. 1 Front View of Axle-Testing Device

[The testing device, as described in the paper above referred to, permits the reactive force of the motor and the force of the dynamometer to act downward through arms of equal length, at the ends of which are knife edges. A lever with three knife edges mounted upon it, has the two outer knife edges adjusted so that the distance between them is equal to the distance (horizontal) between the dynamometer knife edges. The third knife edge divides this distance into segments whose ratio to each other is the same as the gear ratio. The knife edges of the motor and dynamometer are connected to the outer knife edges of the lever, the high-speed motor being coupled to the long arm of the lever and the middle knife edge being supported on the platform scales. A counterweight and rider are mounted on the lever.—EDITOR.]

It will be evident from Fig. 3 that for 100 per cent efficiency the system would be in equilibrium, but since the efficiency is never 100 per cent, the reactive force of the motor will exceed the force of the dynamometer and balance may be restored by shifting the position of the rider weight. The displacement of the rider weight is therefore a measurement of the change of moment, and is a measurement of the power loss.

The motor and transmission, as well as the transmission and worm, were connected by flexible couplings to take care of possible misalignment.

The oil used in the rear axle was Mobil Oil C, and in the transmission, medium mineral oil. The viscosity curves of both oils determined in a Saybolt viscosimeter, are shown in Fig. 4, the vertical scale giving the time, in seconds, required for 60 cc. of oil to pass through a standard orifice.

In order to determine the efficiency of the worm drive the transmission efficiency was determined in a separate test, using a similar apparatus to that shown in Fig. 3. The worm efficiency was obtained by subtracting the transmission efficiency from the total.

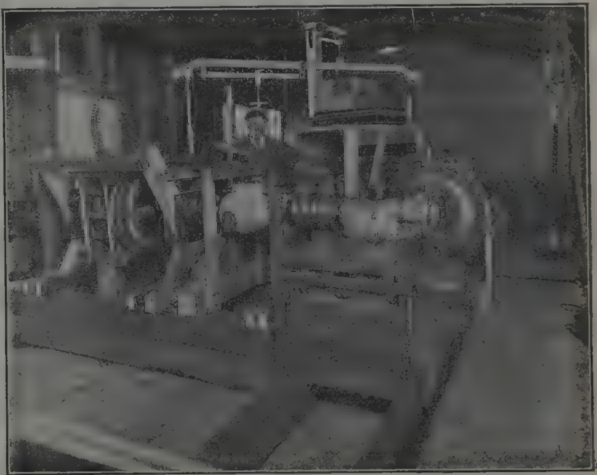

Fig. 2 Rear View of Axle-Testing Device

Efficiency Tests

The first two tests were of the rear axles for a 3-ton truck, designated as Nos. 1 and 2, their engines having a rated capacity of 50 hp. at 1000 r.p.m., the worm ratio being $9^{1}/_{2}$ to 1. The efficiency of worm drive and transmission was determined in first, second and third gears, readings being taken at $^{1}/_{3}$, $^{2}/_{3}$ and full load and $^{1}/_{5}$ overload.

The worm is made of low- (0.2 per cent) carbon steel, no nickel, case-hardened and ground, and has four right-hand threads, circular pitch 1.1562, pitch 3.265, lead angle 24 deg. 20 min. The gear is made of phosphor bronze. The worms in the two axles are supported on ball and roller bearings, respectively.

Test results are plotted in Figs. 5 and 6.

In order to ascertain the effect of severe and enduring service on the efficiency, readings were taken on axle No. 1 after running a total of 110 hr. in low gear (196 r.p.m. of worm) and 49 hp. The efficiency reading was taken under the same condition and found to have improved 1 to $1^{1}/_{2}$ per cent.

The efficiencies of the transmission are shown in Fig. 7, while the net efficiencies of the worm are shown in Fig. 8.

It is remarkable that the efficiency of the transmission (Fig. 7) is the lowest in direct drive, that is, when the gears are running

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[1] SKF Research Laboratory.

[2] Trans.Am.Soc.M.E., vol. 40, p. 101.

For presentation at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

idle. This is due to the power absorbed in churning the oil at high speed, in which case the viscous forces opposing motion are high.

Oil temperature affects efficiency considerably. In case of the Mobil Oil C, higher temperatures in the rear axle housing improve the efficiency. A heavy oil in winter at light loads and high worm speeds, means low efficiency. The effect of temperature in the beginning disturbed the tests until it was found that by starting with heavy loads and finishing with light loads, the temperature could be maintained constant to a satisfactory degree, and thus consistent readings could be obtained. The small figures alongside the curves indicate the oil temperatures in the worm housing.

In connection with the test on axle No. 2, the author wishes to point out that the efficiency in direct drive at low input would have been somewhat better if a higher oil temperature had existed. These low temperatures were due to precautions being taken to avoid overheating at the end of the test.

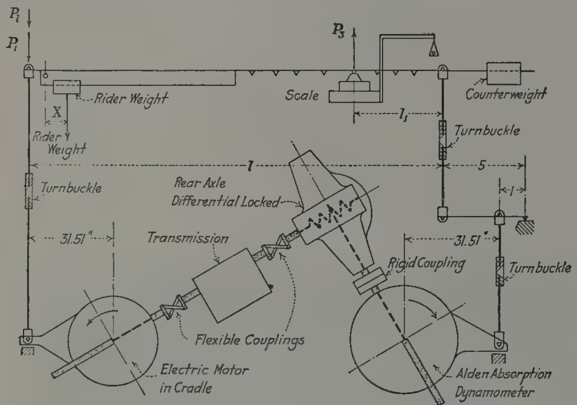

Fig. 3 Diagram of Axle-Testing Device

Temperature of the Worm Thrust Bearings

On account of the high worm loads carried by the worm thrust bearings, information on the bearing temperature was considered valuable.

To determine maximum temperature conditions, first (low) gear and full load was considered the most severe. Under this condition axle No. 1 stood up very well, and the maximum bearing temperature was 185 deg. fahr. with an oil temperature in the housing of 275 deg. fahr. after 5 hr. continuous running under an input of 49 hp. Axle No. 2 under same speed and practically same load gave a bearing temperature of 572 deg. fahr. with an oil temperature in the housing of 400 deg. fahr. after 90 min. continuous running under 52 hp. Due to the excessive heat the worm and the thrust bearing were completely destroyed.

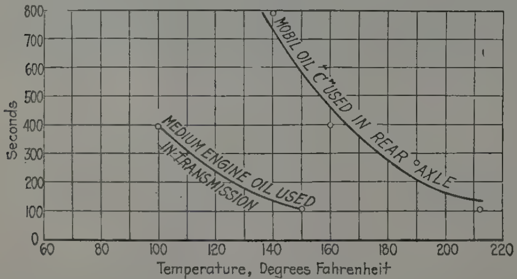

Fig. 4 Curve Showing Variation in Viscosity of Oils Used in Rear Axle and Transmission

It was then decided to modify the test for axle No. 2 to resemble actual conditions such as are encountered by a loaded truck in snow or on a sandy road, with subsequent hill climbing. Due to the damage done in the preceding test, the worm and thrust bearing were replaced by new ones. Curves plotted in Fig. 9 show the temperature rise with the time. The thrust bearing of axle No. 2 shows a final temperature slightly over 200 deg. fahr. in high gear, full speed and 52 hp. In a comparatively short

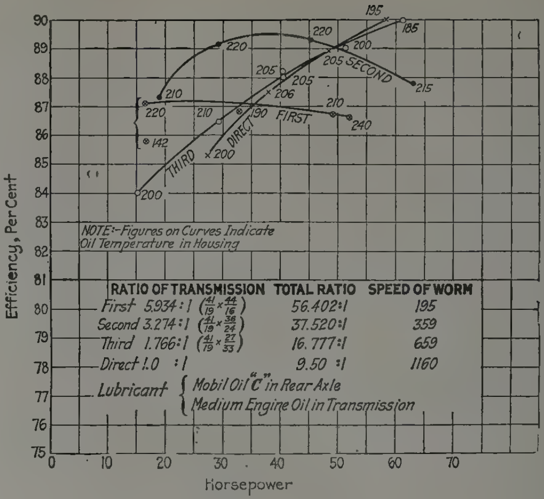

Fig. 5 Efficiency Curves of No. 1 Rear-Axle Worm Drive and Transmission at Different Gears

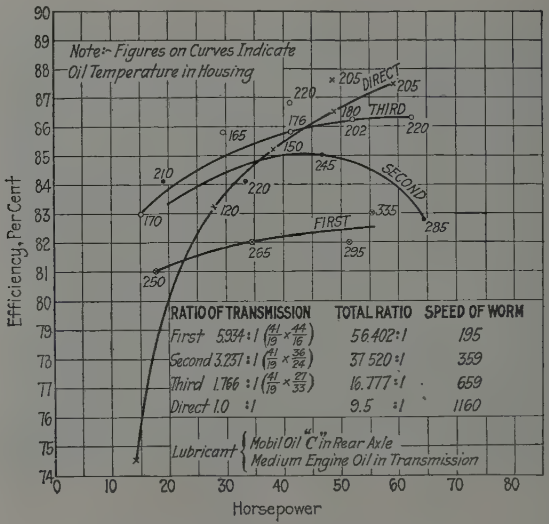

Fig. 6 Efficiency Curves of No. 2 Rear-Axle Worm Drive and Transmission at Different Gears

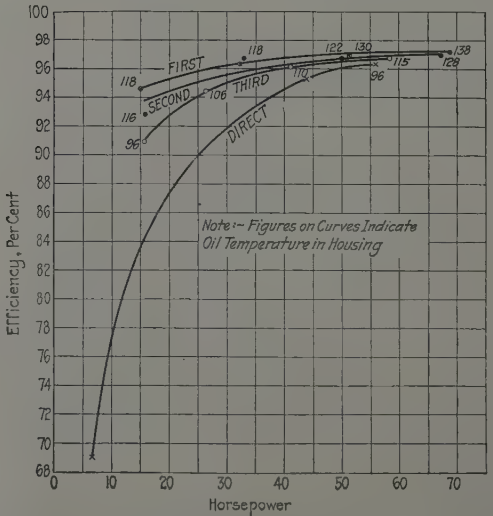

Fig. 7 Efficiency Curves of Truck Transmission at Different Gears

TABLE 1 TABLE SHOWING RESULTS OF FATIGUE TESTS ON WORMS

		A	B	C	D
1	Worm ratio	$9^1/_2 : 1$	$9^1/_2 : 1$	$9^1/_2 : 1$	$8^3/_4 : 1$
2	Hp. on motor	49	46.8	41.2	42.2
3	Hp. transmitted to worm wheel	46.5	44.5	39	40
4	R.p.m. of worm	196	196	196	196
5	Net effective torque, in-lb	14,900	14,300	12,500	12,800
6	Pitch radius	1.63	1.37	1.37	1.39
7	Angle of lead	24°20′	30°26′	30°26′	32°12′
8	Angle of pressure	30°	27°30′	27°30′	27°15′
9	No. of threads	4	4	4	4
10	Tangential component of tooth pressure, lb	9,150	10,400	9,150	9,230
11	Vertical component of tooth pressure, lb	11,700	9,200	8,100	7,550
12	Item 11 less a percentage for friction loss	Less 10% 10,500	Less 12% 8,100	Less 15% 6,900	Less 11% 6,700
13	Resultant radial load, lb	14,000	13,100	11,500	11,500
14	Worm thrust, lb	18,000	15,500	13,200	13,300
15	Half span, in	6.2	7.2	7.2	6.6
16	Max. bending moment, in-lb.	68,300	62,600	54,300	51,000
17	Sectional area of core, sq. in.	4.6	2.9	2.9	2.6
18	Life of worm, hr	118 hr.	46 min.	1 hr. 30 min.	8 hr. 40 min.
19	Life of worm, total no. revolutions	1,390,000	9,000	17,600	102,000
20	Remarks	Thread broken off; core unbroken	Core broken at center	Core broken at center	Core broken at center

time the heat in the thrust bearing became excessive. The break in the curve indicates the period of stop needed for changing gears, knife edges on the balance beam, etc. The slightly higher horsepower input in case of axle No. 2 was due to the difficulty in predetermining the correct scale weights.

Fatigue Tests on Worms

The running tests conducted under uniform speed and load offered the opportunity to record the life of four worms, three of which were different in design. All these worms broke after a certain number of revolutions under a heavy load. The load, however, did not exceed the maximum which the axle was supposed to carry in low gear.

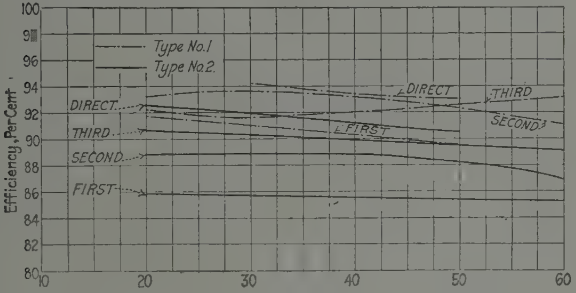

Fig. 8 Efficiency Curves of Rear-Axle Worm Drive at Different Gears

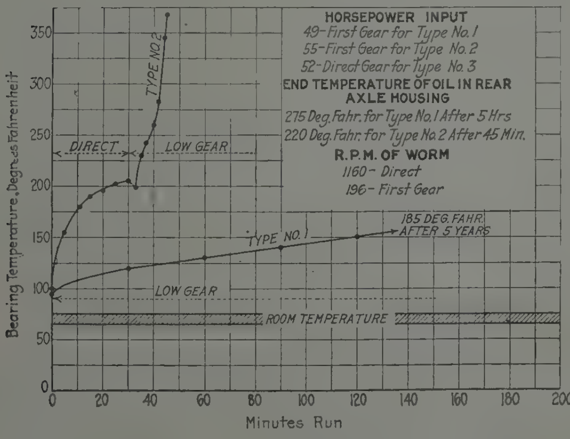

Fig. 9 Temperature Curves of the Worm Thrust Bearings

All worms tested were made of about 0.2 per cent carbon steel. They contained no nickel and were case-hardened, the working surfaces being ground. The test arrangement was the same as shown in Figs. 1 and 2, enabling the input to be accurately determined. During each test the horsepower was kept practically constant.

For the benefit of rear-axle designers a few important endurance data are tabulated in Table 1. Worm designated *A* is the one whose efficiency is shown in Fig. 5. *B* and *C* are identical in design, but different from *A*. *D* has a different worm ratio than *A*, *B* or *C*.

Fig. 10 gives an idea of the worm fractures. In case of worms *B*, *C* and *D* their life could probably have been increased considerably by avoiding sharp corners at the root of the thread. This seems to be a small matter, yet it is of great importance. It is well known from theoretical and experimental investigations that sharp corners tend to concentrate or localize stresses. In case of static loads and ductile material this concentration of stresses is much reduced after the elastic limit is transgressed, which is brought about by the permanent stretching of the metal. The stresses are thus redistributed and will be shifted to other parts originally stressed to a smaller extent.

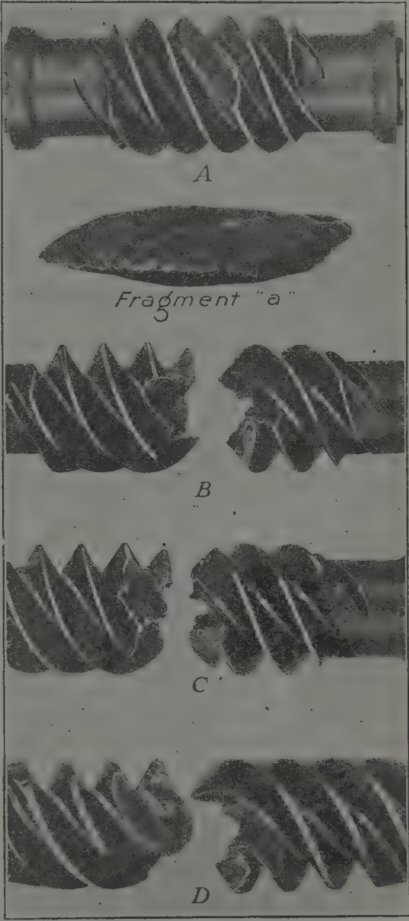

Fig. 10 Worms that Failed on Fatigue Test.

The case, however, is different with stresses often repeated or reversed and failure may occur even within the elastic limit. The relieving of stresses at the peaks will not take place and the corners will form starting points for cracks, which, when once started, will rapidly progress until the section is so weakened that a sudden break occurs. Thus, it is important, that a radius as large as possible be specified by the designer and checked by the inspector.

Effect of Fittings on Flow of Fluids Through Pipe Lines

By DEAN E. FOSTER,[1] TULSA, OKLA.

In the layout of piping in power plants, heating systems, refineries, and other projects, the engineer is frequently confronted with the problem of making proper allowance for the resistance offered by fittings to the flow of liquids and gases. A number of formulæ and tables have been published giving such information for globe valves and elbows, but none for fittings in general. Konrad Meier, Mem.Am.Soc.M.E., in his excellent treatise entitled, The Mechanics of Heating and Ventilation, has given the subject of the effect of fittings on resistance to flow a very careful study and has presented data thereon in the form of seven charts. In his work of the past several years the writer has found these charts to be very useful in the design of piping for uniform distribution of liquids and gases and in the selection of equipment for producing the necessary force for moving fluids, the only objection being the time required when using them. After some study of the equations used in their construction, however, it was found to be a comparatively easy matter to formulate the following relations between the frictional resistance of pipes of various sizes and the various screwed fittings commonly used, and from these relations to establish tables showing the lengths of pipe equivalent in resistance to that offered by fittings.

For the flow of water through pipe lines Mr. Meier uses the formula

$$H_f = \frac{0.0257}{2g} \times v^{1.86} \times \frac{L}{d^{1.25}}$$

where H_f = loss of pressure in ft.
v = velocity in ft. per sec.
d = diameter in in.
L = length in ft.

This equation agrees within 5 per cent with Gardner S. Williams' formula, which is so widely used in this country.

For resistance offered to flow by fittings, Mr. Meier gives the following:

$$H_r = 1.38r \times \frac{v^{1.86}}{2g}$$

where H_r = ft. of pressure loss per fitting
r = a factor of resistance whose value depends upon the shape of the fitting
v = velocity of the fluid in ft. per sec.

By combining these two equations we obtain

$$L_e = 53.75r \times d^{1.25}$$

where L_e represents the number of feet of pipe equivalent in resistance to a fitting and the other factors as before. Table 1 has been made up from this equation and may be used for water, crude or refined petroleum oils of 32 deg. B. gravity or lighter, or other non-viscous liquids.

For the flow of high-pressure steam through pipes Mr. Meier uses the equation

$$P_f = \frac{W}{144} \times 0.0257 \times \frac{v^{1.95}}{2g} \times \frac{L}{d^{1.2}}$$

where P_f = pressure in lb. per sq. in. to overcome frictional loss.

For resistance offered to flow by fittings he gives:

$$P_r = \frac{W}{144} \times 1.12r \times \frac{v^{1.95}}{2g}$$

By combining these two formulæ we obtain

$$L_e = 43.7rd^{1.2}.$$

There is no reason to assume that the flow of gas or air through fittings should occasion losses differing from those caused by the flow of steam. Hence the writer assumes that the equivalents of Table 2 may be used for all three fluids.

TABLE 1 EQUIVALENT LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING NON-VISCOUS LIQUIDS[1]

Formula Used: $L_e = 53.75rd^{1.25}$

Nominal Pipe Size, in.	Actual Inside Diameter, in.	Gate Valve	Long-Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size 1/4	Standard Elbow or on Run of Tee Reduced in Size 1/2	Angle Valve	Close Return Bend	Tee through Side Outlet	Globe Valve
Factor of Resistance		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
1/2	0.662	0.335	0.442	0.56	0.89	1.20	1.34	1.79	2.68
3/4	0.824	0.475	0.627	0.79	1.27	1.71	1.90	2.52	3.80
1	1.049	0.640	0.844	1.07	1.72	2.30	2.56	3.40	5.12
1 1/4	1.38	0.902	1.19	1.51	2.42	3.24	3.61	4.80	7.22
1 1/2	1.61	1.09	1.43	1.83	2.92	3.92	4.36	5.79	8.72
2	2.06	1.49	1.96	2.50	3.99	5.36	5.96	7.92	11.92
2 1/2	2.46	1.86	2.46	3.13	5.00	6.72	7.47	9.93	14.94
3	3.06	2.46	3.25	4.11	6.66	8.87	9.86	13.11	19.72
3 1/2	3.54	2.92	3.80	4.91	7.84	10.53	11.70	15.56	23.40
4	4.026	3.44	4.53	5.77	9.22	12.37	13.70	18.28	27.50
4 1/2	4.506	3.95	5.20	6.63	10.60	14.22	15.80	21.01	31.60
5	5.047	4.57	6.00	7.68	12.20	16.47	18.30	24.33	36.60
6	6.065	5.72	7.55	9.61	15.30	20.61	22.90	30.45	45.80
7	7.024	6.90	9.10	11.59	18.50	24.84	27.60	36.70	55.20
8	7.981	8.10	10.69	13.60	21.70	29.16	32.40	43.09	64.80
10	10.020	10.70	14.10	17.97	28.70	38.52	42.80	56.92	85.60
12	12.090	12.50	17.80	22.68	36.20	48.60	54.00	71.82	108.00

TABLE 2 LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING STEAM, AIR, OR GAS

Formula Used: $L_e = 43.7rd^{1.2}$

Nominal Pipe Size, in.	Actual Inside Diameter, in.	Gate Valve	Long-Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size 1/4	Standard Elbow or on Run of Tee Reduced in Size 1/2	Angle Valve	Close Return Bend	Tee through Side Outlet	Globe Valve
Factor of Resistance....		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
1/2	0.622	0.031	0.41	0.52	0.84	1.12	1.25	1.66	2.50
3/4	0.824	0.044	0.57	0.73	1.17	1.57	1.75	2.33	3.50
1	1.049	0.057	0.77	0.98	1.57	2.11	2.34	3.11	4.68
1 1/4	1.380	0.082	1.07	1.37	2.19	2.94	3.27	4.35	6.54
1 1/2	1.610	0.098	1.29	1.64	2.63	3.52	3.92	5.21	7.84
2	2.067	1.32	1.74	2.23	3.55	4.77	5.30	7.05	10.60
2 1/2	2.469	1.64	2.16	2.75	4.39	5.91	6.56	8.71	13.12
3	3.068	2.13	2.81	3.59	5.72	7.69	8.54	11.40	17.08
3 1/2	3.548	2.53	3.34	4.26	6.80	9.10	10.13	13.50	20.26
4	4.026	2.96	3.90	4.97	7.94	10.65	11.84	15.75	23.68
4 1/2	4.506	3.27	4.45	5.66	9.05	12.14	13.50	17.95	27.00
5	5.047	3.88	5.11	6.42	10.40	13.95	15.51	20.60	31.02
6	6.068	4.81	6.35	8.09	12.90	17.35	19.27	25.60	38.54
7	7.023	5.75	7.59	9.66	15.40	20.70	23.02	30.60	46.08
8	7.981	6.70	8.85	11.20	17.90	24.10	26.80	35.60	53.60
10	10.02	8.75	11.54	14.70	23.40	31.50	35.00	46.60	70.00
12	12.09	10.90	14.40	18.35	29.30	39.30	43.70	58.10	87.40

Many charts and diagrams for the quick determination of steam pipe sizes have been published, but they have all been constructed under the assumption that dry saturated steam was the fluid to be carried. The accompanying chart, Fig. 1, however, solves problems involving the carrying of either dry saturated or superheated steam. In order that its use may be clear the following case has been assumed, the pressure loss in lb. per sq. in. per 100 ft. being desired:

Average steam pressure in line..........	140 lb. abs.
Superheat............................	150 deg.
Amount of steam to be delivered........	1700 lb. per min.
Size of pipe..........................	10 in. standard

In the solution shown in Fig. 1 the chart is entered on the horizontal line representing 150 deg. of superheat. This line is followed to the left until it intersects the curve representing 140 lb. pressure. From this intersection the dashed vertical line is followed down to its intersection with the horizontal dashed line representing 1700 lb. of steam. From this intersection the inclined dashed line is followed to its intersection with the horizontal line representing 10-in. pipe. The vertical thus determined gives the loss required as 2.08 lb. per 100 ft. Had a 12-in. pipe line been used, the loss would have been only 0.81 lb.

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[1] Consulting Engineer, Foster and Gilmore, Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

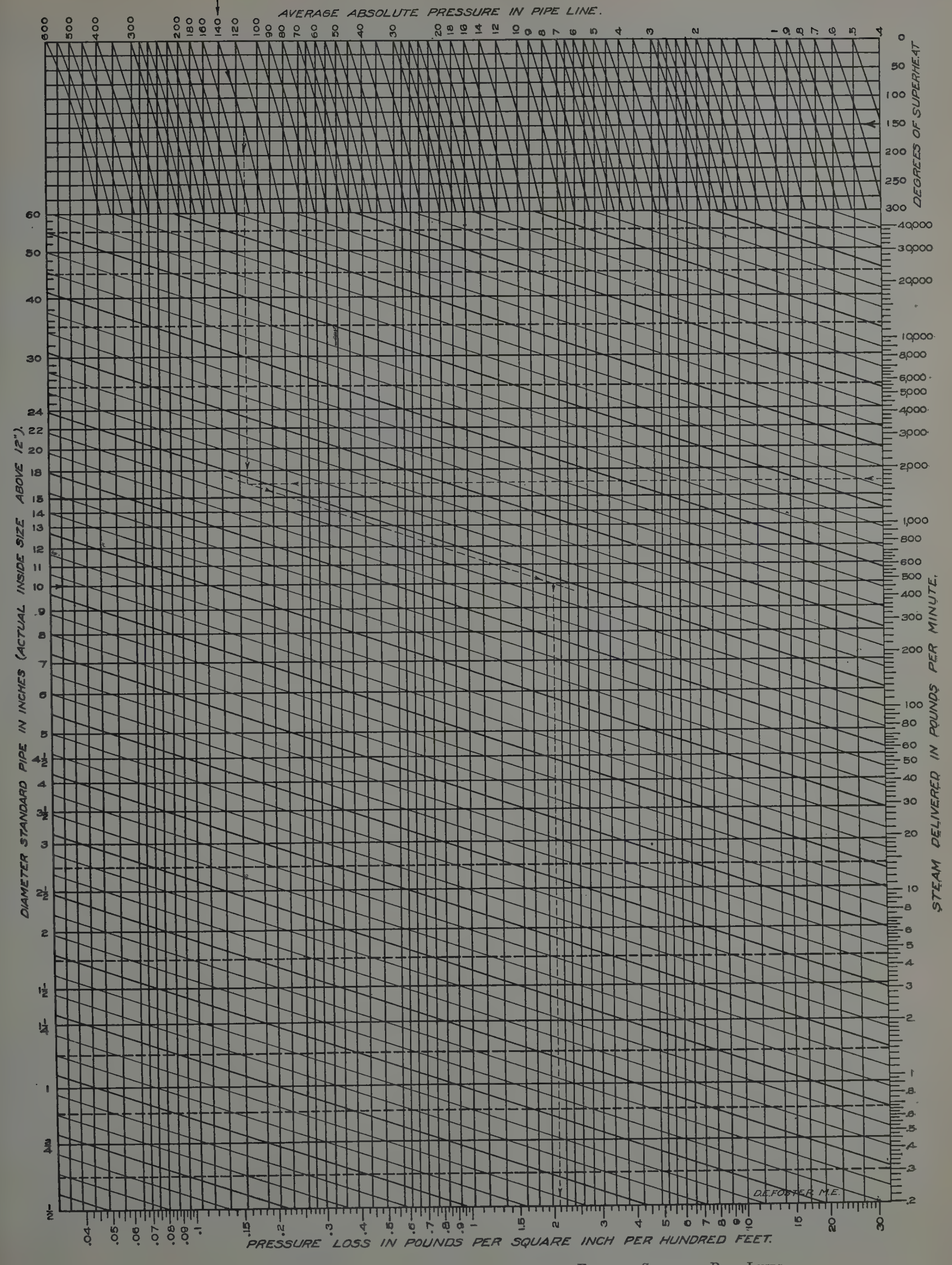

Fig. 1 Graphical Solution of Babcock's Formula for Flow of Steam in Pipe Lines

Fig. 1 can be used for the solution of any case where four of the variables are known and the fifth is to be determined. For the solution of problems involving dry saturated steam, enter the chart at the top at the point representing the pressure assumed and follow a vertical line from this point to its intersection with a horizontal representing the desired quantity of steam. The remainder of the solution will be the same as outlined for superheated steam. If the part representing superheated steam were omitted, this chart would be very similar to one constructed by H. V. Carpenter, Mem.Am.Soc.M.E., and published a number of years ago in *Power*.

To show the use of Table 2 an example has been taken of a 6-in. steam line 1000 ft. long, containing 5 gate valves, 3 angle valves, 20 standard tees, and 10 standard ells. From Table 2 for steam, air, and gas, these fittings are found to be equivalent to 332.10 ft. of 6-in. pipe as follows:

5 Gate valves, each 4.81	24.05
3 Angle valves, each 17.35	52.05
20 Standard tees on run, each 6.35	127.00
10 Standard ells, each 12.90	129.00
Total allowance	332.10 ft.
Actual pipe length	1000.00
Equivalent total length	1332.10 ft.

The chart shows that with an initial pressure of 150 lb. and a total loss of 5 lb. pressure or 0.375 lb. per 100 ft. this line will transmit about 225 lb. of steam per min. If the effect of the valves and fittings had been ignored, the calculation would show a capacity of 260 lb. of steam per min. This would have indicated a flow of $11^1/_2$ per cent more than the real capacity of the line. This error in capacity will be the same, no matter what pressure drop is allowed through the line.

Use of Table 1 is illustrated by the solution of the following problem which assumes that a 4-in. line is to handle 26.2 cu. ft. of water per min. through a horizontal run of 50 ft., at which point the line rises at right angles 35 ft., thence runs horizontally 120 ft. to a tee heading a manifold consisting of five pieces of 4-in. pipe 12 ft. long connected by 4-in. tees, each delivering one-sixth of the total quantity of water. A centrifugal pump is to be selected and properly speeded to handle this quantity of water. The pump is to be located 10 ft. above the water surface.

Since the frictional resistance of pipe varies approximately as the square of the quantity of water passing through it, it will be convenient to combine the last 12 ft. of horizontal run with the first tee. This will give us 6 sections of 4-in. pipe each 12 ft. long and having a connecting tee. From Table 1 for liquids we find a 4-in. tee equivalent to be 4.53 ft. of 4-in. pipe, making each section the equivalent of 16.53 ft. in length. From Cox's tables for flow of water through pipe lines we find a loss of 2.563 ft. per 100 ft. for a 4-in. line handling 26.2 cu. ft. of water per min. The loss for the first section which carries all the water will be 16.53 × 2.563/100 or 0.424 ft. For the second section, which carries $^5/_6$ of the total, the loss will be as the square of the quantity carried, or $^5/_6 \times {}^5/_6 \times 0.424 = 0.295$ ft.

For the entire manifold the losses will be as follows:

Section 1 $(6/6)^2 \times 0.424$	0.424
Section 2 $(5/6)^2 \times 0.424$	0.295
Section 3 $(4/6)^2 \times 0.424$	0.198
Section 4 $(3/6)^2 \times 0.424$	0.131
Section 5 $(2/6)^2 \times 0.424$	0.047
Section 6 $(1/6)^2 \times 0.424$	0.012
Total loss for manifold	1.107 ft.

For the remainder of the line we have:

Suction line	10
300 diameters for pump	100
First horizontal run	50
Riser	35
Second horizontal run	108
Three 4-in. standard elbows, each 9.22	27.66
Total equivalent length of pipe to Section 1 of manifold	330.66 ft.

and from the foregoing:

Loss on 330.66 ft., 2.563/100 per ft	8.47
Loss through manifold	1.11
Total loss	9.58 ft.

The total pumping head then will be as follows:

Suction head	10.00
Elevation	35.00
Friction head	9.58
Total head	54.58 ft.

CONSTITUTION AND PROPERTIES OF BOILER TUBES

(Continued from page 605)

not thus visibly subject to grain growth. Not only was there evident a marked growth in the ferrite grains for the irons ranging in carbon content from 0.006 to 0.251 per cent, inclusive, but in the irons in this range where there was a visible quantity of carbon existing as pearlite, very apparent agglomeration or balling up of this constituent was in evidence.

TABLE 1 EFFECT OF CARBON CONTENT ON GRAIN GROWTH IN DEFORMED IRON WHEN HEATED BELOW THE CRITICAL TEMPERATURE

Carbon Content, Per cent	Number of Ferrite Grains per Square Inch Undeformed	Deformed
0.006	3.9	1.9
0.103	25.4	13.4
0.203	63.4	23.0
0.251	26.3	16.0
0.315	(*a*)	(*a*)

(*a*) Grains too small to count. Photomicrographs from both the undeformed and deformed areas show no appreciable difference in grain size.

Service Comparison between Medium-High- and Low-Carbon Boiler Tubes

Not only do all theoretical considerations point to the procurement of an increased life for boiler tubes through a raising of the carbon content, but the results of some actual tests on which data are now available seem to indicate and confirm this claim.

This test was started in 1916–1917 by placing in the front row of four of the 750-hp. Stirling boilers at the Park Place Heating Plant of the Detroit Edison Co. tubes of a medium-high carbon content averaging around 0.30 per cent carbon, and in four other boilers at the same plant operating under the same loads at about the same time tubes with a carbon content between 0.08 and 0.18 per cent.

The results given in the "Service Test" (Table 2) speak for themselves, for of the medium-high-carbon tubes only about one-half have been replaced, and of the low-carbon tubes, more than a 100 per cent replacement has been necessary.

TABLE 2 SERVICE TEST ON MEDIUM-HIGH- AND LOW-CARBON BOILER TUBES AT PARK PLACE HEATING PLANT, DETROIT, MICH.

Boiler Number	Installation Number	Installation Date	Replacement Number	Replacement Date
HIGH-CARBON TUBES IN FRONT ROW				
3	29	June 19, 1916	27 15	July 27, 1918 Summer, 1920
6	29	May 9, 1916	13 5 1	Sept. 11, 1917 July 15, 1919 Summer, 1920
7	29	June 19, 1917		
8	29	June 9, 1917		
Totals,	116		61	
LOW-CARBON TUBES IN FRONT ROW				
1	29	Sept. 23, 1916	27 5	July 12, 1918 Summer, 1920
2	29	Sept. 18, 1916	10 27 7	Sept. 28, 1917 July 11, 1920 Summer, 1920
4	29	June 14, 1916	18 5 13 5	Jan. 6, 1917 July 27, 1918 June 17, 1919 Summer, 1920
5	10 19	June 5, 1916 Aug. 3, 1917	10	August 3, 1917
Totals,	116		127	

This paper has been prepared not for the purpose of suggesting radical changes in boiler-tube composition nor for the purpose of criticizing present boiler-tube manufacturing practices, for all things considered, it is on a very high plane with respect to quality. It has been prepared, however, to present certain facts, especially those relating to grain growth, to which tubes of the commonly accepted composition are so subject; and in view of these acts to question whether tubes with a carbon content varying between 0.30 and 0.35 per cent would not insure longer tube life and safer boiler operation than tubes with a carbon range between 0.08 to 0.18 per cent.

Principles of the Gyro-Compass

By GEORGE B. CROUSE,[1] BLOOMFIELD, N. J.

The following brief outline covers the main factors in the development of the gyro-compass up to the present time. It explains briefly the principles of the gyroscope and the simple gyro-compass; discusses the disturbing forces acting on the gyro-compass when on shipboard; and finally takes up the three major problems of design, namely, the compensation of the disturbing forces, the methods of suspension, and methods of damping.

A SUBSTITUTE for magnetism as a directing force has long been sought and in 1852 it appeared that the work of Leon Foucault bid fair to solve this problem by means of the gyroscope. The eminent French scientist found that by the use of the gyroscope, or spinning wheel, a mechanical device could be constructed which, when properly mounted, would indubitably seek the meridian and which depended in no way on the earth's magnetism. The spinning wheel exhibits two properties which distinguish it from inert matter, termed, respectively, "fixity of plane" and "precession."

Fixity of plane expresses the fact that a spinning mass acquires by virtue of its rotation a sort of enhanced inertia which strongly resists any attempt to change the plane of rotation. It is a common error to believe that the gyroscope maintains its plane of rotation in space irrespective of any force applied to it. This is decidedly not true. Even a force of very small magnitude will gradually change the plane of rotation, although it does so in a very novel manner.

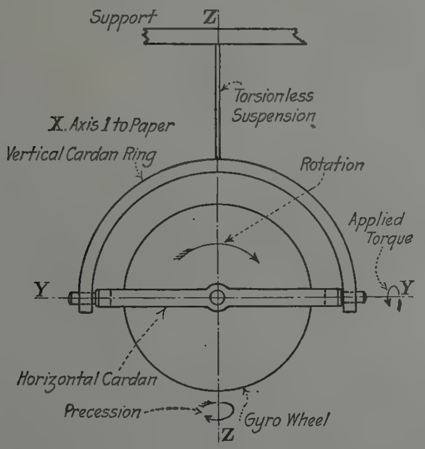

Fig. 1 Simple Gyroscopic System

Precession is illustrated in Fig. 1, which shows a simple gyroscopic system. If torque be applied about, say, the Y-Y axis, with the intent of forcing the plane of rotation of the wheel to rotate about this Y-Y axis, no such result will ensue, but instead the plane will rotate slowly about the Z-Z axis, which is perpendicular to the axis of the applied torque. This action is precession.

The angular velocity of the precessional motion, Ω, will depend upon I, the moment of inertia of the wheel, ω, the angular velocity of rotation of the wheel, and upon T, the torque applied about the Y-Y axis as above, the quantities being connected with the precessional velocity Ω by the equation

$$T = I\omega\Omega$$

The direction of procession will depend on the direction of rotation of the wheel as well as upon the direction of the applied torque, the relation being correctly given in Fig. 1. A reversal either of the direction of the torque or the rotation of the wheel will change the direction of precession, whereas a reversal of both of these will not change the direction of the precession.

Simple Gyro-Compass

With these facts in mind the explanation of the Foucault compass becomes very simple. The elements of the device are shown in Fig. 2. A gyroscope is so mounted in cardan rings that it may freely turn in any direction and the entire system is perfectly balanced about all three of the mutually-perpendicular axes, save only the axis Y-Y, about which it is made slightly pendulous.

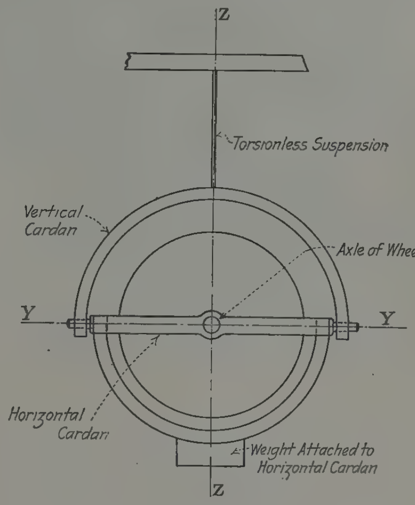

Fig. 2 Simple Foucault Compass

Let us suppose such a device set up on the equator of the earth, with the axle pointing east-west, as shown in position 1, Fig. 3. It is obvious that the direction of the perpendicular at any point on the equator is continually changing, being rotated in a clockwise direction, when viewed from the south, once in 24 hr. The gyroscope, on the other hand, due to its property of fixity of plane, will resist this rotation, with the result that as the earth rotates

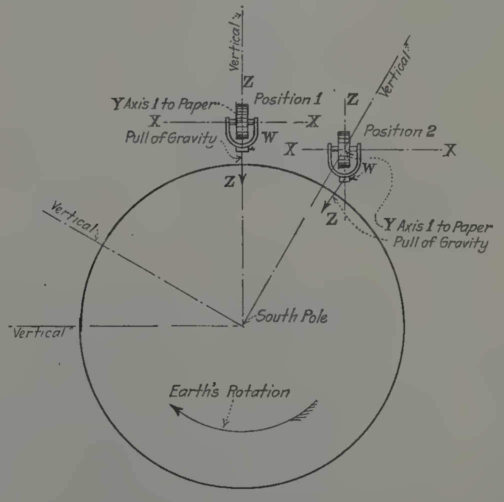

Fig. 3 Diagram to Illustrate Tilting Effect of Earth's Rotation on Gyro-Compass

the east-pointing end of the wheel will rise with respect to the earth's surface as shown in position 2. As soon, however, as this occurs the weight on the bottom of the wheel case will introduce a couple about the *Y-Y* axis, due to the pull of gravity, and the phenomenon of precession occurs, causing the wheel to rotate about the vertical *Z-Z* axis.

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[1] Consulting Engineer.

Abstract of paper to be presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

A consideration of the foregoing action will show that the east end of the axle will continue to rise and that the weight will act until the axle has passed through the meridian plane, after which the earth will act to depress this end of the axle, finally bringing it into the horizontal. As soon as the axle is horizontal the gravity couple vanishes and the precession ceases. However, the earth continues to act on the instrument, the axle is again tilted and the wheel again swings back toward the meridian plane. Thus the compass continues to perform a series of oscillations back and forth across the meridian until damped out by friction or other means. It will at once be apparent from Fig. 4 that when the compass is at rest with the axle in the meridian and horizontal there is no tilt introduced by the earth and the system is in equilibrium. It may also be readily shown that the action is the same as that described when the compass is located at any other latitude than the equator, with the exception of a small error introduced by the vertical component of the earth's rotation.

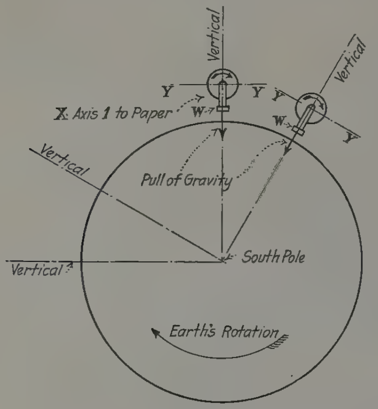

Fig. 4 Gyro-Compass in Equilibrium in Respect to Effect of Earth's Rotation

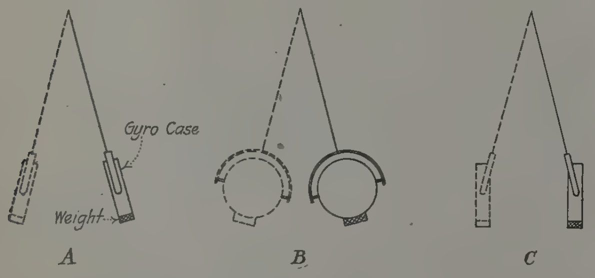

Fig. 5 Diagram Showing Effect of Intercardinal Accelerations

It is thus seen that the compass derives its directive force from the rotation of the earth and the force of gravity acting on the pendulous mass of the wheel. In reality an instrument such as that described functions perfectly—granting the necessary degree of mechanical refinement—when placed on a fixed platform where forces other than those mentioned cannot be impressed on the system. However, when the Foucault pendulum is placed on a moving platform, such as a ship at sea, other forces are impressed on it, due to the motion of translation of the ship over the sea and the motions due to wave action. The forces resulting from these causes are in no way to be distinguished from the useful or directive force and are in fact many times greater in magnitude than the useful force, so that under these conditions the instrument becomes inoperative.

It was this fact which delayed the introduction of the gyrocompass in navigation for nearly sixty years after its discovery; and it was the solving of this problem which acted to produce the varied forms of compass which it is the purpose of this paper to describe.

Disturbing Forces Acting on the Compass

We may broadly divide the disturbing forces acting on the compass at sea into two classes: First, those due to the motion of translation of the ship; and second, those due to motions of the ship about various axes fixed in relation to the ship: to which may also be added the error introduced by the vertical component of the earth's rotation, and in some cases small errors due to elements of the compass design. Of these the elimination of forces due to the rolling and pitching of the ship has largely dictated the major factors of the compass design.

These rolling forces, acting on the simple compass or pendulous gyroscope, exhibit their effects chiefly on intercardinal headings, being theoretically absent on north-south or east-west headings, and increasingly troublesome up to 45 deg. from these directions.

A convenient method of investigating these rolling forces is to place the complete compass on a pendulum which may swing in a plane making a known angle with the plane of the meridian. In the first case, suppose this plane to coincide with the plane of the meridian. Then, if the compass wheel is not running and the supporting pendulum is swung, the pendulous mass of the wheel case will cause the case to line up with the pendulum, due to the combination of the forces of gravity and acceleration, as shown at *A* in Fig. 5. When the wheel is spinning, the case will not line up with the pendulum, since it is stabilized about the east-west axis, and the force of acceleration on either end of the swing will therefore be balanced by a gyroscopic reaction. (*C*, Fig. 5). These forces are equal and opposite on each end of the swing and no disturbance of the compass will result. Should the plane of swing of the pendulum be east and west, the case will swing freely about the axle of the wheel, and again no disturbing force will result. (*B*, Fig. 5).

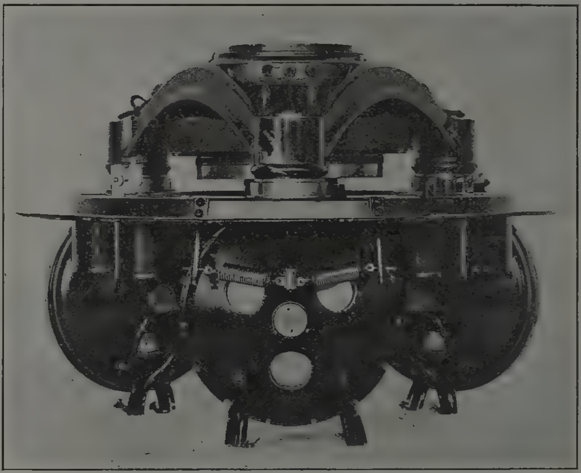

Fig. 6 Sensitive Element of the Anschutz Compass

Assume now that the plane of swing makes an angle with the meridian of, say, 45 deg. There will be a component of swing in a north-south direction which will cause a force to be impressed on the pendulous mass, and, as before, it will be equal and opposite on each end of the swing. In addition to this, there will be a movement of the case about the axle of the wheel, due to the east-west component of the swing. This latter motion will cause the point of application of the force of acceleration to be shifted from one side to the other of the vertical axis; and thus, while the impressed force will be equal on each end of the swing, and in an opposite direction, it acts to form a pulsating couple about the vertical whose direction is always the same.

Another way of regarding this phenomenon is to consider that whereas the wheel when spinning is stabilized about an east-west axis, it is perfectly free to rotate about the north-south axis, thus causing the apparent moments of inertia about these two axes to be widely different. The result of this is that when forces tend to rotate the system about any horizontal axis other than the major axes mentioned above, a torque is set up about the vertical which ultimately displaces the compass from the meridian.

Compensation of the Disturbing Forces

From this description it is obvious that the simplest way of remedying the difficulty is to stabilize the compass in both directions, or, in other words, about the north-south axis as well as about the east-west axis, and one of the earliest methods was based on this principle. Fig. 6 is from a photographic view of the sensitive element of the Anschutz compass. This compass uses three wheels, all attached to the orienting element, one of which operates in the same manner as the Foucault pendulum, the other two being mounted with their axles at an angle to each other and to the main wheel. By this method the apparent moment of inertia of the system about the north-south axis is greatly increased and at the same time a portion of the useful directive force of both of the auxiliary wheels is utilized to orient the compass on the meridian.

In a later form of the Anschutz compass for use on submarines and other small craft subjected to violent rolling, a fourth wheel is added, which serves only as a stabilizer, the axle being vertical.

It is to be noted, however, that in the Anschutz compass complete stabilization of the sensitive element is not aimed at, but rather the reduction of the disturbing torque to within a limit where its effect on the compass will not be detrimental. On the other hand, a number of attempts have been made to solve the problem by the independent stabilization of the platform on which the sensitive element is mounted. None of the attempts has been so far successful, due, probably, to the difficulty of maintaining the necessary accuracy in the stabilizing apparatus. Numberless trials have demonstrated the fact that it is practically impossible to stabilize a platform on a rolling ship to anywhere near the accuracy required for this purpose.

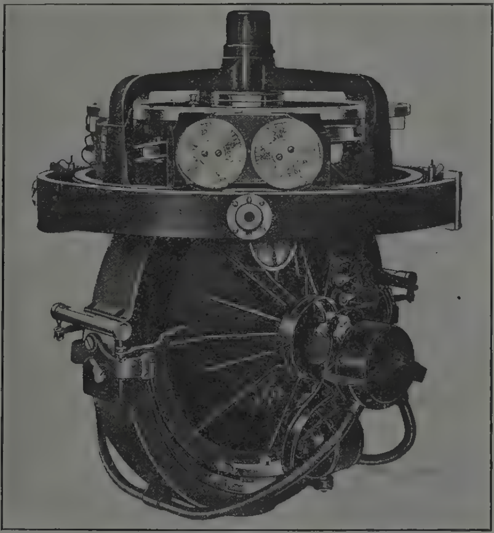

Fig. 7 Sperry Gyro-Compass, Showing Floating Ballistic

Another early solution of the problem was the ingenious method developed by the Sperry Gyroscope Company. This method consisted in stabilizing the point of attachment between the gyroscope and the pendulous mass as shown in Fig. 7. The stabilizing device, known as a "floating ballistic" is essentially a pendulum stabilized by a small gyroscope. We find that there again the stabilizing principle is used only to reduce the magnitude of the disturbing forces, and neither the Anschutz principle of three wheels, nor the Sperry floating ballistic, completely compensates.

In 1916 and 1917 a form of compass was developed by Harry L. Tanner, of the Sperry Gyroscope Company, in which complete compensation of the disturbing forces was accomplished. This compass, a photograph of which is shown in Fig. 8, and a line drawing in Fig. 9, utilizes two wheels of equal size and rotating at equal speeds but in opposite directions. One of these wheels is mounted as in the Foucault pendulum and may be regarded as the compass wheel. The second wheel, located to the east of the meridian and known as the east gyro, precesses in a direction opposite to that of the compass wheel under the influence of disturbing forces, and this fact is utilized to impress a force on the west wheel equal and opposite to the disturbing torque; this torque being transferred between the wheels by means of a yielding connection between them. At the same time the mounting is such that a large portion of the available directive force of the east wheel is transferred to the west and thus utilized. The compass is completely compensated and was adopted by the U. S. Navy for use on destroyers, a class of vessels whose rolling characteristics are notorious.

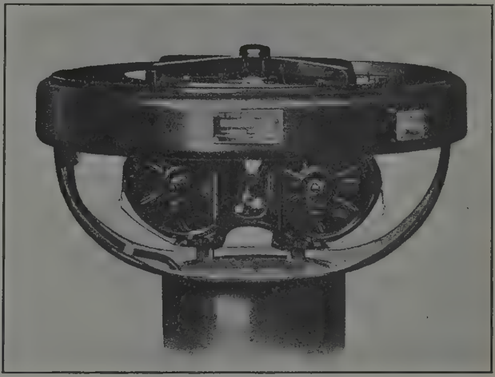

Fig. 8 Sperry Twin Gyro-Compass

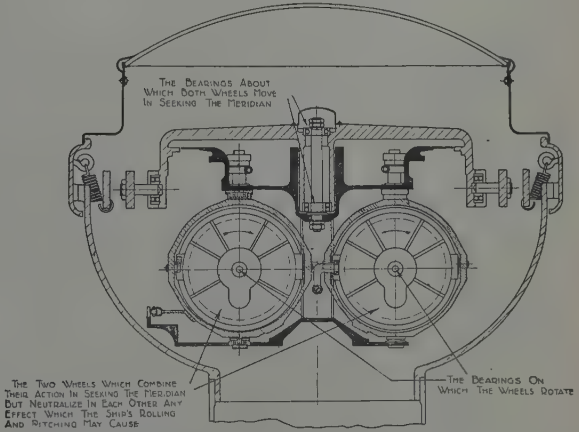
The Bearings About Which Both Wheels Move In Seeking The Meridian
The Two Wheels Which Combine Their Action In Seeking The Meridian But Neutralize In Each Other Any Effect Which The Ship's Rolling And Pitching May Cause
The Bearings On Which The Wheels Rotate

Fig. 9 Partial Section of Sperry Twin Gyro-Compass

In the last year a new method of compensation has been developed in the United States by the Sperry Company and in England by Perry and Brown. This consists of the use of a nonpendulous wheel, the gravity couple being introduced in a novel manner. The device, the elements of which are shown in Fig. 10, consists of a gyroscope which is perfectly balanced about all of the three axes. On both the north and south sides of the gyro casing and attached to the casing are bottles containing mercury which are connected by means of a small tube. The action of the device as a compass is then very similar to the simple compass in that the earth acts to tilt the wheel as usual, whereupon the mercury flows from the higher to the lower bottle, thus upsetting the equilibrium about the east-west axis. The torque thus generated causes precession about the vertical axis as before. It should be noted, however, that this torque is oppositely directed to that generated by the usual pendulous mass and therefore it is necessary to rotate the wheel in a direction opposite to that of the ordinary compass. In other words, the wheel must rotate in a counterclockwise direction when viewed from the south.

The explanation of the compensating features of this type of compass lies in the fact that the motion of the mercury from one bottle to the other, under the influence of the forces set up by the rolling of the ship, is out of phase with the motion of the compass in its gimbal rings. While the principle involved is new and no great number of compasses built on this principle have been in service, very exhaustive trials of the instrument have been made in comparison with other standard compasses. All of these tests show that the compensation is practically perfect, in addition to which the simplicity of the instrument strongly recommends it.

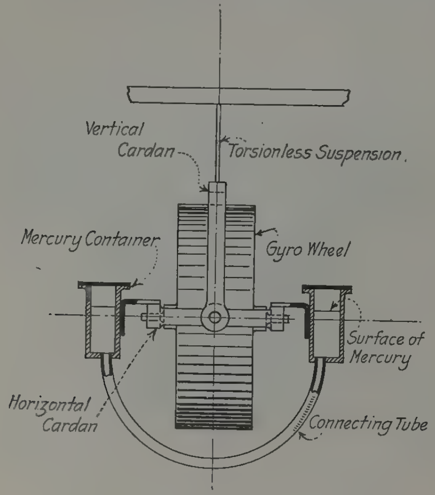

Fig. 10 Mercury Ballistic Compass

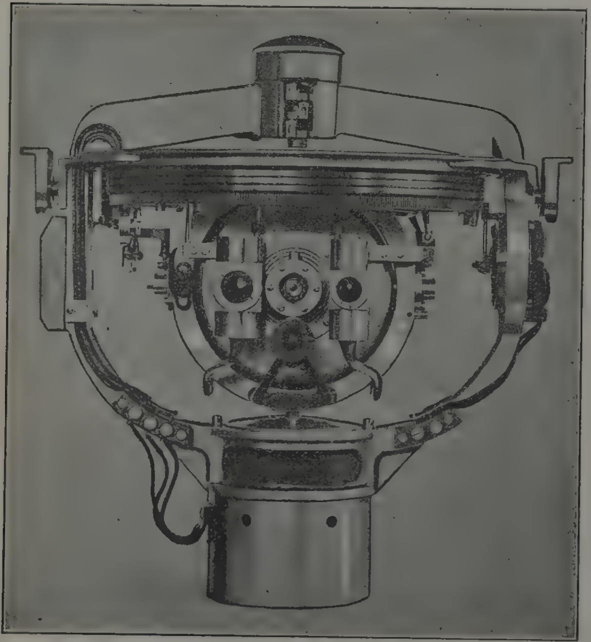

Fig. 11 Perry-Brown Compass

In Fig. 11 is a view of the Perry-Brown compass and Fig. 12 shows the mercury attachment or "mercury ballistic" of the Sperry compass, the mercury bottles being indicated by the arrow.

Methods of Suspension

Perhaps of equal importance to the problem of compensation, from the standpoint of the designer of gyro-compasses, is the question of suspension of the sensitive element. While the directive force of the gyro-compass is many times larger than that of the magnetic compass, in most forms of the instrument the masses to be oriented are more than proportionately greater; therefore some means of carrying these masses on a suspension bearing must be devised which is as nearly as possible without friction.

The mercury float forms a very simple method of suspension which immediately suggests itself from the somewhat similar mounting of the magnetic needle in the type known as the liquid compass. The Anschutz compass utilizes the mercury suspension with considerable success and has done so for a number of years. Its great advantage is its simplicity, but on the other hand a number of practical difficulties present themselves. The mercury collects dust from the air and also oxidizes rapidly unless it is surrounded by some non-oxidizing atmosphere such as hydrogen. When the metal becomes dirty or oxidized the sensitivity of the mounting is greatly decreased.

In the original compass constructed by Foucault a filament suspension was employed similar to that used today for galvanometers, oscillographs and similar instruments. Such a suspension was very sensitive, but, of course, was not suitable for shipboard use since it was not capable of making a complete revolution in azimuth. The Sperry Company applied this torsionless-filament suspension to the practical instrument in a manner which has proved so successful that it has been used on all of the various types of compasses which they have designed. It consists essentially of a suspension head carrying a filament consisting of a bundle of very fine piano wires, to the lower end of which is attached the sensitive element. When the sensitive element of the compass turns in azimuth, or the binnacle turns relatively to the sensitive element, this filament is continuously unwound by means of an electrical follow-up system, the elements of which are shown in Fig. 13. It consists of a so-called phantom element, driven in azimuth by an electric motor. As shown in the figure the motor is controlled by trolley contacts operated by the motion of the sensitive element in azimuth relative to the phantom. This suspension is very sensitive and has the additional advantage that a continuous, small oscillation of the phantom relative to the sensitive element is maintained, which acts to reduce the friction of the vertical guide bearings necessary in any type of suspension.

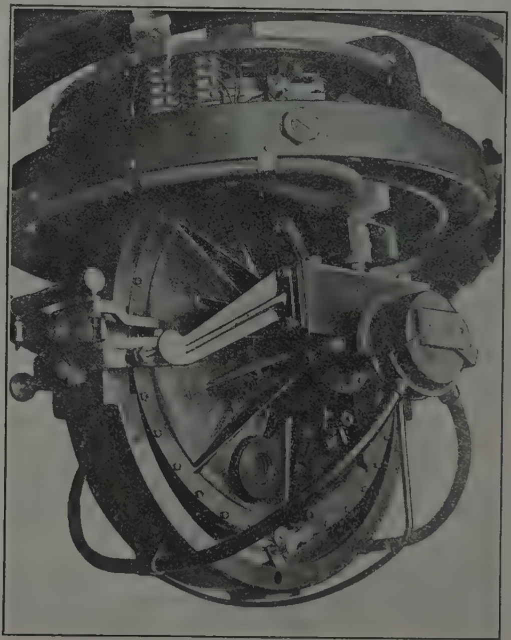

Fig. 12 Mercury Ballistic Attached to Sperry Compass

The Perry-Brown compass uses a form of suspension which has also shown great sensitivity. It is similar in principle to the oil-float thrust bearings used on vertical turbines and similar machinery. A small pump is employed to force oil between the surfaces of a step bearing, thus maintaining a perfect film for the separation of the surfaces. The pulsations of the pump give the sensitive element a small up-and-down oscillation and thus acts as a means of reducing the static friction of the vertical guides as in the Sperry instrument.

The jeweled point has frequently been suggested and tried as a gyro-compass suspension, but has never met with any measure of success, due principally to the large weights which must be supported on extremely small areas.

Methods of Damping

The third major design element, and one which has been the subject of considerable study and which has resulted in many different solutions, is the means for damping the oscillations of the compass system in azimuth. With the very sensitive suspensions which must be employed, the compass will continue to swing back and forth across the meridian for many hours without coming to rest and some special means must be employed to damp these oscillations in a reasonable length of time. The damping employed is generally very large, usually from 60 to 90 per cent. Since in all compasses so far constructed the period has had to be fixed at 85 min. of time, even with a very high damping factor, several hours are required for the compass to settle on the meridian.

An early solution of the damping problem was that employed in the first Anschutz compass, which consisted of two air jets controlled by a pendulum mounted on the case of the wheel, as shown diagrammatically in Fig. 14. The air pressure was supplied by the rapid rotation of the wheel, the nozzles being so arranged that when the wheel was tilted by the earth's rotation one or the other of the nozzles was opened, causing a reaction about the vertical axis which caused precession in a direction to bring the axle back into the horizontal plane. It is obvious that this action will slow down the motion of the wheel in azimuth and that thus the necessary damping will be secured. The controlling pendulum was not stabilized, but this did not seem to interfere with the action of the device, since its average position, of course, was vertical. Various practical difficulties arose with the device in practice, however, and it was early abandoned.

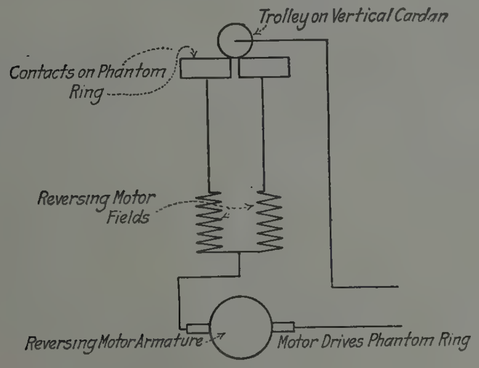

Fig. 13 Elements of Sperry Electrical Follow-Up System

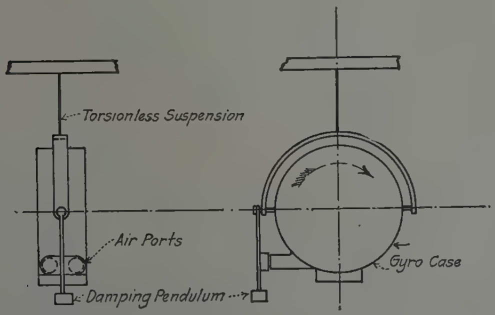

Fig. 14 Anschutz Air-Damping Device

In the Sperry compasses the damping is secured in connection with the power-driven phantom element. In the compass known as the "Mark I" the pendulous mass, instead of being made an integral part of the wheel case, is supported on the phantom element on horizontal bearings. The attachment of this mass to the wheel is made slightly to the east of the vertical, and thus when the wheel tilts a large reaction is applied about the horizontal axis to secure the directive action and a small reaction about the vertical axis to effect damping.

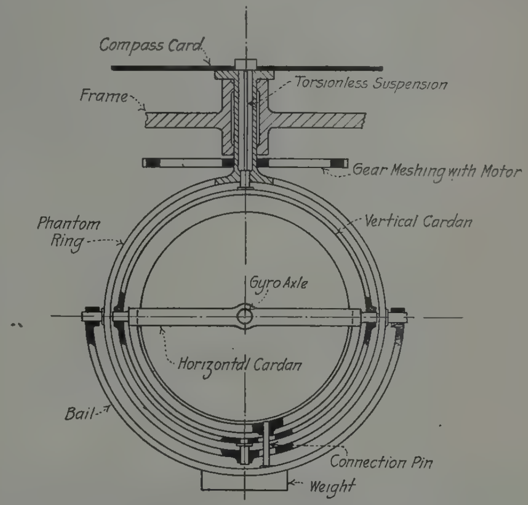

Fig. 15 Sperry Mechanical Damping Device

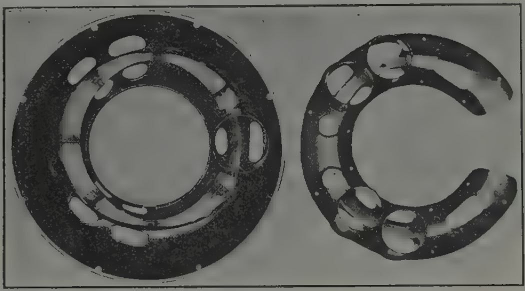

Fig. 16 Anschutz Damping Tanks

In the present Anschutz compasses damping is obtained by the use of a flow of oil from the north to the south side of the horizontal axis through very small orifices, the action being very similar to that of the mercury ballistic described above, except that the flow of oil is made so slow that it is out of phase with the oscillation of the compass in azimuth. The oil thus is continually acting to oppose the torque of the main gravity couple, and the oscillations are thus damped. In the Anschutz compass the oil is allowed to flow through a number of reservoirs in series, the openings between the reservoirs being very small. A photograph of the damping tanks is shown in Fig. 16.

Having solved the three major design problems outlined above, the question of building a successful working instrument resolves itself largely into a question of correct mechanical design and excellency of workmanship. The delicacy of the instrument is such that the utmost care must be exercised in both the design and construction to insure the correct and permanent alignment of the parts and the reduction of friction about all axes, to insure freedom from vibration and similar factors.

The Heat-Insulating Value of Cork and Lith Board

Results of a Series of Tests Conducted at the Engineering Experiment Station of Kansas State Agricultural College, Showing Cork Board to be Superior to Lith Board as a Heat-Insulating Material

By A. A. POTTER,[1] J. P. CALDERWOOD,[2] A. J. MACK,[3] and L. S. HOBBS[4]

The following paper treats of a series of tests made at the Engineering Experiment Station of the Kansas State Agricultural College for the purpose of determining the conductivity and heat-transmitting properties of cork board and lith board. The apparatus employed is described in detail, and the procedure followed in the experimental work is carefully outlined. Formulae for calculating results are also presented. The results obtained by the authors show that as a heat-insulating material cork board is slightly better than lith board; that is, for the samples tested the lith board had a conductivity approximately 5 per cent greater than that of the cork board.

IN the following paper are presented the results of a series of tests which were conducted at the Engineering Experiment Station of the Kansas State Agricultural College upon the heat-insulating properties of two refrigerating materials—nonpareil cork and lith board. The general arrangement of apparatus used for the tests is shown in Fig. 1. The test box itself is made of nonpareil cork board and is a cube whose internal dimensions are 2 ft. square. One side of this box is removable for the insertion of specimens of other materials and within it are three resistance coils which serve as an electric heater during the test. These coils are arranged so that one, two, or three may be joined in series, thus making it possible to vary the intensity of the heat supply. Current is supplied by a 220-volt d.c. line and in order to maintain a uniform voltage at the heating element, a 32-volt storage battery is floated across the supply main. A variable resistance is used to regulate the current input.

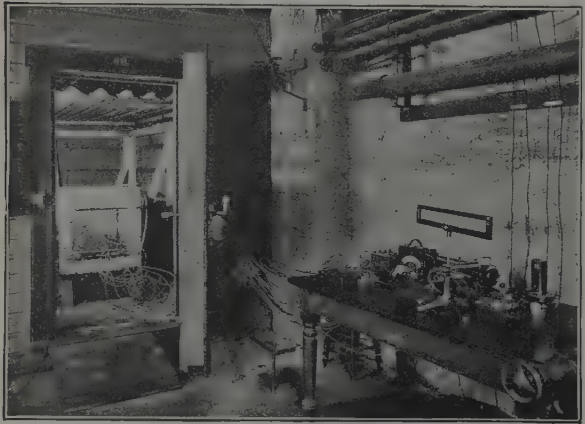

Fig. 1 Apparatus Used in Testing the Heat-Transmitting Properties of Cork and Lith Board

The electrical energy consumed by the heating coils is measured by a single millivoltmeter, for through the use of a multiplier, a shunt and a two-way mercury switch the same instrument is made to measure both the impressed voltage and amperage supplied to the coils.

At regular intervals during the test temperature measurements were taken at the internal and external surfaces of the top, bottom, front, and sides of the test box, care being taken in inserting the thermometer to eliminate all possible influence from the air, both external or internal. Temperature measurements were also taken on the front side of the test box, at points 2 in. and 4 in., respectively, from both internal and external surfaces (see Fig. 3).

These temperature measurements were accomplished by the use of thermocouples, made from No. 12 gage copper and constantan wire welded together to form the junction. Since the range in temperature during such an investigation would be low and the consequent electromotive force small, the most convenient method for the measurement of the impressed electromotive force produced by the thermocouple was by balancing it with a standard electromotive force.

The wiring diagram of the temperature-measuring equipment is shown in Fig. 2. The various thermocouples are joined by means of a 14-point switch to the portable potentiometer indicator and in order to produce a more sensitive potentiometer this instrument was of a special design, being provided with connections for a sensitive external galvanometer, which made possible temperature measurements of great accuracy. The scale division of the instrument gives a direct reading of 0.01 millivolt, so that it is possible to estimate to 0.001 millivolt.

The thermocouples with their cold ends maintained at 32 deg. fahr. by an ice bath were calibrated throughout their range of use against a standard mercury-in-glass thermometer. This calibration was accurate to 0.5 deg. No calibration of the thermocouples was made below the 32 deg. fahr. point, as the deviation of the calibration curve above and below this point is probably negligible.

The refrigerator or thermal testing room was 9 ft. by 12 ft. and 10 ft. high. It contained 600 ft. of 2-in. direct-expansion ammonia piping and its walls, floor, and ceiling were insulated with cork board. The refrigerating equipment includes a 5-ton Frick ammonia-compression system, and a 1-ton York machine used as an auxiliary. The ammonia compressor is steam-driven. A pressure gage is inserted in the evaporating coils so that the pressure in the coils can be regulated as desired by opening or closing the suction valve to the compressor or the expansion valve to the coils. Since the boiling point of the ammonia in the evaporating coils is dependent upon the pressure, this regulation gave an indirect means of controlling the temperature in the refrigerator.

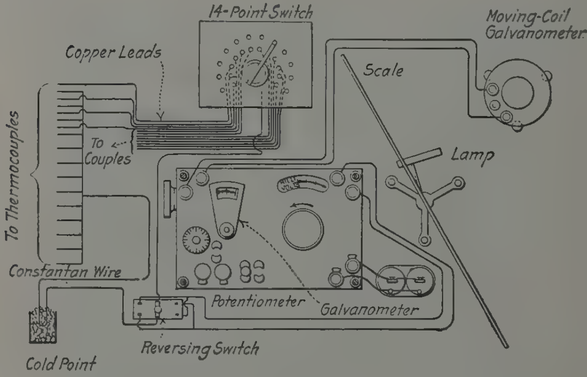

Fig. 2 Wiring Diagram of Temperature-Measuring Equipment

Method of Testing

The method of testing was as follows: The test box with its equipment was first placed in the refrigerator. The refrigerating machine was then started and the pressure in the evaporating coils so regulated that the desired temperature in the refrigerator

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would be produced. No other regulation of the refrigerating equipment was made, except that of maintaining the pressure constant in the evaporating coils. While it was impossible to predict the exact temperature that would result with this regulation, the final temperature when conditions became adjusted remained practically constant at a value of approximately 10 deg. fahr. Lower temperatures were possible but required a longer period of operation before conditions became constant.

As a preliminary, temperature readings of two thermocouples, one inside and the other outside the test box, were taken, and when these became constant the test was then started. The length of test was one hour, and readings of the electrical energy supplied and the temperatures as indicated by the various thermocouples were recorded every 10 min.

Since no standard method of procedure has been suggested for the testing of heat-insulating materials along the lines followed in the present work, preliminary tests were first made in order to establish such a method. These tests were to determine the effect of the temperature of the source of heat supply upon the various results, and the probable time that would be required for a variation in the temperature external to the test box to be transmitted to the interior.

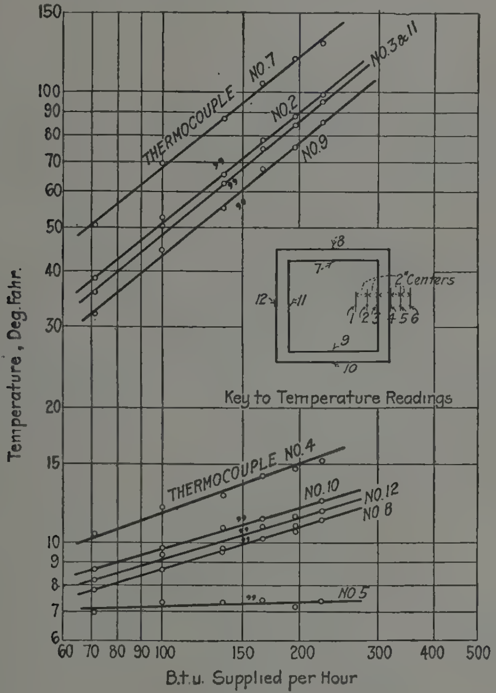

Fig. 3 Temperature Readings Obtained in Test Series No. 1 on Cork Board

From these preliminary results it was concluded that the heating element should consist of the three coils in series as this produced more uniform conditions in the interior of the box, and the insulating effect of the inner air film would approach a condition similar to that found in actual installations. With three coils in series and a current input sufficient to produce a temperature of 70 deg. fahr. in the interior of the box when the external temperature was 10 deg. fahr., the temperature of the heating element was 170 deg. fahr.

It was also shown by these preliminary tests that at least $2^1/_2$ hr. would be necessary, after conditions external to the test box became uniform, before the internal temperature conditions could be expected to become constant. Furthermore, if after external and internal conditions became constant, external conditions for some uncontrollable reason varied, the internal temperatures could reasonably be expected to remain uniform for a period of 2 hr.

Following these preliminary tests the investigation of the insulating properties of both cork and lith board were then made. These tests consisted of two series:

Series 1. These tests were made to show the heat-insulating properties of cork. The external temperature of the test box was maintained constant at approximately 10 deg. fahr. while internal conditions were varied by means of the electric heater described above. Temperature measurements were taken at the internal and external surfaces of the top, bottom, front and back sides of the test box and also at points 2 and 4 in., respectively, from the internal and external surfaces of the front side (see Fig. 3).

Series 2. These tests were identical with those of Series 1, but the front side of the cork-board test box was replaced by a 3-in. lith board.

Method of Calculating Results

In calculating the results from the tests of Series 1, the conductivity of the cork was assumed constant for the various temperatures involved in each test. The heat equivalent of the electrical energy was equated to the heat conducted through the various sides as shown by the following equation, the temperature difference of the two measured sides being assumed as the average of the front and back temperature differences.

$$H = 4C\left\{(t_7 - t_8) + (t_9 - t_{10}) + (t_{11} - t_{12}) + (t_3 - t_4) + 2\left[\frac{(t_{11} - t_{12}) + (t_3 - t_4)}{2}\right]\right\} \ldots\ldots\ldots\ldots [1]$$

where H = the heat equivalent of the electrical input per hr.

C = conductivity of the cork in B.t.u. per sq. ft. per deg. per hr.

4 = a constant = sq. ft. of internal surface per side of test box

t_3 = temperature, deg. fahr., internal surface, front side

t_4 = temperature, deg. fahr., external surface, front side

t_7 = temperature, deg. fahr., internal surface, top side

t_8 = temperature, deg. fahr., external surface, top side

t_9 = temperature, deg. fahr., internal surface, bottom side

t_{10} = temperature, deg. fahr., external surface, bottom side

t_{11} = temperature, deg. fahr., internal surface, back side

t_{12} = temperature, deg. fahr., external surface, back side

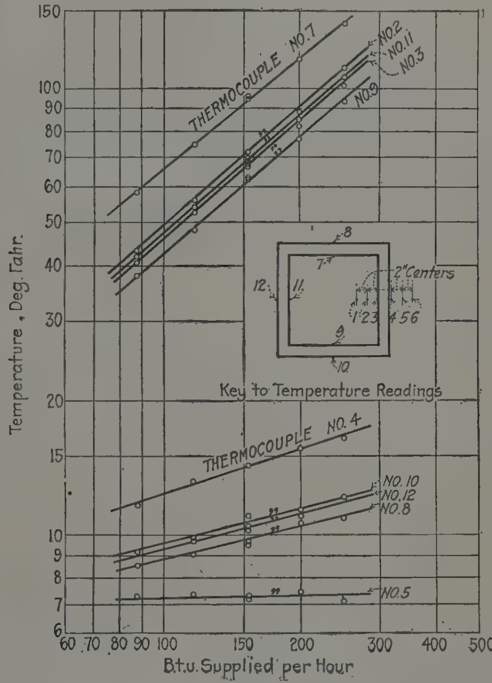

Fig. 4 Temperature Readings Obtained in Test Series No. 2 on Lith Board

The heat transmission of the cork was calculated by dividing the heat conducted through the front surface of the test box by the temperature differences measured 2 in. from the internal and external surfaces of the front side. The heat conducted through the front surfaces was estimated from the determined value of the conductivity and the inner and outer surface temperatures of the front side.

The calculation of the conductivity of the lith board from the tests in Series 2 gave rise to two methods:

Method 1. The first method was similar to that used in the calculations for the conductivity of cork. The heat transmitted through the cork of the test box was calculated from the temperature differences of the cork surfaces and the conductivity of the cork as determined in the tests of Series 1. The heat transmitted through the cork was then subtracted from the heat equivalent of the electrical input and the difference represents the heat transmitted through the lith board from which the conductivity may be determined. The equation of this relation is as follows:

$$4C_1(t_8 - t_4) = H - 4C[(t_7 - t_8) + (t_9 - t_{10}) + (t_{11} - t_{12}) + 2k(t_{11} - t_{12})] \ldots\ldots\ldots\ldots [2]$$

where C_1 = conductivity of lith board in B.t.u. per sq. ft., per deg. per hr.

C = conductivity of cork board in B.t.u. per sq. ft. per deg., per hr. as determined from tests of Series 1

k = the proportion of the temperature difference of the sides to the temperature difference of the back surface

and all other factors have the same significance as in Eq. [1].

TABLE 1 RESULTS OF TESTS ON 3-IN. CORK BOARD, SERIES NO. 1

Test No.		1C	2C	3C	4C	5C	6C
Temperature at thermo couples, deg. fahr.	1	36.95	53.69	64.94	79.79	93.20	104.53
	2	36.68	53.97	64.04	78.53	91.84	103.93
	3	33.86	50.90	60.08	75.02	87.80	100.22
	4	8.33	12.65	11.20	14.18	17.96	20.12
	5	4.82	8.06	5.90	7.52	10.60	12.27
	6	4.86	7.70	5.54	7.07	10.40	11.93
	7	48.36	70.25	85.55	104.18	121.37	133.16
	8	5.66	9.40	8.14	10.27	14.00	16.16
	9	29.86	45.14	53.78	67.64	78.80	90.85
	10	6.56	10.40	9.23	11.30	14.90	17.39
	11	33.86	50.90	61.16	75.38	88.16	100.26
	12	6.09	10.04	8.24	10.94	14.18	16.68
B.t.u. per hr. supplied heater		70.62	100.00	136.26	166.16	197.69	226.56
Average conductivity, B.t.u. per sq. ft. per deg. fahr. per hr.		0.102	0.098	0.105	0.104	0.108	0.109
Average conductivity, B.t.u. per sq. ft. per in. thickness per 24 hr.		7.34	7.06	7.56	7.49	7.78	7.85
Average temp. of cork, deg. fahr.		21.22	32.01	36.50	45.37	53.77	61.10
Transmission,[1] B.t.u. per sq. ft. per deg. per hr.		0.082	0.084	0.088	0.089	0.093	0.096
Transmission,[1] B.t.u. per sq. ft. per deg. per 24 hr.		1.97	1.97	2.11	2.13	2.23	2.30

[1] Based on temperatures 2 in. from surface.
Density of sample, 11.8 lb. per cu. ft.

The tests of Series 1 showed that the temperature differences of the front and back sides of the test box were dissimilar. This was possibly due to slight differences in temperature at different points in the refrigerator. Therefore, in order to estimate the temperatures of the sides of the box when testing lith board, the relation between the temperatures at the back sides of the test box was determined from the tests in Series 1. From the conductivity of the lith board thus found, the heat transmitted through that surface was calculated. With this heat known, the heat transmission was calculated as in the tests of Series 1.

Method 2. The second method for calculating the conductivity of lith board was based on the theory that the conductivity of two different materials is proportional to their temperature differences when subjected to the same conditions. In order to apply this theory to the tests of Series 2, the probable temperature of the front of the test box if cork had been inserted was obtained. Since there was a difference between the external temperatures of the front and back sides of the test box in the tests of Series 1, a constant, k_2, was obtained from their proportion. Thus, the external temperature of the back side in Series 2 could be used in estimating the probable external temperature of the front side. This theory is expressed in equation form as follows:

$$C_1 = C\,\frac{(t_{11} - k_2 t_{12})}{(t_3 - t_4)} \ldots\ldots\ldots\ldots [3]$$

where k_2 = a constant = the relation between the external temperature of the front and back sides obtained from the tests of Series 1

and all other factors have the same significance as in Eqs. [1] and [2].

Results of Tests

The results of these tests are given in Tables 1 and 2. Table 1 gives the results of the tests of Series 1, which is based upon the cork-board test box, and Table 2 gives the results of the tests of Series 2, in which the removable cover of the test box was replaced by 3-in. lith board.

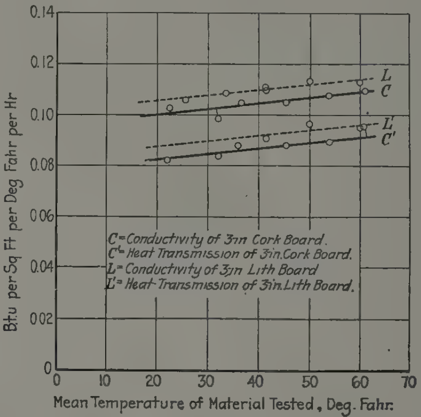

Fig. 5 Curves Showing Conductivity and Heat Transmission of Cork and Lith Board

The conductivity of the lith board as calculated by both methods agreed very closely. The values secured by the Method 2, however, were more consistent and were used in other calculations in preference to those determined by the Method 1. One other feature was noticeable in connection with the Method 2; namely, consistent results of the conductivity could be secured when conditions were not uniform enough to warrant the use of the Method 1. This fact was made use of in tests Nos. 4L and 3L, in which the temperature difference was small and the time that would have been required to secure uniform conditions extremely long. Since the temperatures were not absolutely constant during these tests, the heat transmissions of tests Nos. 4L and 3L were omitted as they could not be productive of representative results.

TABLE 2 RESULTS OF TESTS ON 3-IN. LITH BOARD, SERIES NO. 2

Test No.		4L	3L	2L	2XL	1L	5L
Temperature at thermocouples, deg. fahr.	1	42.89	56.84	72.81	72.73	88.93	110.92
	2	42.80	56.66	72.37	72.50	88.16	111.38
	3	40.19	53.06	67.91	67.91	84.79	103.38
	4	11.03	14.00	14.90	15.35	16.34	16.07
	5	6.80	8.24	7.88	8.60	8.24	6.71
	6	6.53	7.88	7.70	8.33	7.79	6.62
	7	57.56	75.20	96.12	95.72	116.60	138.74
	8	8.00	9.92	10.39	10.80	11.39	10.49
	9	37.22	48.56	63.20	63.33	77.18	92.21
	10	8.60	10.69	11.66	11.75	11.75	11.75
	11	41.09	54.50	69.87	69.80	84.92	105.62
	12	8.60	10.54	10.99	11.64	12.20	11.75
B.t.u. per hr. supplied heater		87.85	116.66	153.70	153.98	199.16	249.85
Conductivity, B.t.u. per deg. per sq. ft. per hr. Method 1.		.....	.....	0.112	0.118	0.126	0.109
Conductivity, B.t.u. per deg. per sq ft. per hr. Method 2.		0.104	0.107	0.110	0.109	0.107	0.113
Conductivity, B.t.u. per deg. per in. thickness per 24 hr.		7.49	7.70	7.89	7.85	7.70	8.06
Transmission,[1] B.t.u. per sq. ft. per deg. per hr.		.....	......	0.090	0.090	0.092	0.094
Transmission,[1] B.t.u. per sq. ft. per deg. per 24 hr.		.....	......	2.17	2.16	2.21	2.26

[1] Based on temperatures 2 in. from surface.
Density of sample, 10.8 lb. per cu. ft.

The location of the thermometer elements, as indicated in the results will be understood by reference to the key to temperature

(Continued on page 654)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

SUBJECTS OF THIS MONTH'S ABSTRACTS

- Combustion Process in the Oil Engine
- Solid Injection and Compressed-Air Injection Compared
- Steinbecker Process of Diesel-Engine Injection
- Heat Transfer in Flues
- 20,000-r.p.m. Single-Stage Turbo-Blower
- Air Forces on Circular Cylinders
- Cast Iron for Locomotive Cylinder Parts
- Cast Iron, Air Furnace and Cupola, Compared
- Corrosion of Iron, Influence of Copper, Manganese and Chromium Impurities
- Portland Cement, Long-Time Tests
- Hydraulic Lime, Long-Time Tests
- Volcanic Ashes, Long-Time Tests
- Pluto Stoker and Low-Grade Fuels
- Fuel Economy Report of the British Association
- Therm as New Unit for Sale of Gas
- Flow of Oil in Pipes
- Flow of Oil and Viscosity
- Wave-Power Tools, Dorman
- Constantinesco Sonic Waves Applied to Power Tools
- Flexible Pipe, Dorman
- Pumps for Corrosive Liquids
- Ceratherm Pumps
- Roto-Piston Pumps
- Spring-Scragging Machine
- Heat Transfer through Insulation and Geometric Form
- Dynamical Method for Raising Gases to a High Temperature
- Air Compressors, Causes of Overheating

The Combustion Process in the Oil Engine

The Combustion Process in the Oil Engine. Discussion of the various stages constituting the combustion process in an oil engine and criticism of some of the new constructions.

The first of the stages discussed is the fuel injection. For this there are three methods available: namely, injection by compressed air, solid injection without the use of air, and injection by partial combustion in a separate chamber or retort.

As regards air injection, the influence of atomizers, needles and nozzles on the shape of the diagram has been carefully investigated and sufficient data are now available to make it possible to secure a good diagram and a smokeless combustion, no matter whether a medium-pressure, high-speed Diesel engine is desired such as was used on the submarines, or one with good regulation such as a multi-cylinder type engine used for dynamo drive. Likewise, Neumann and others have investigated the influence of the size of the droplets on the performance of the Diesel engine and the size itself has been measured and determined.

The subject of solid injection has been investigated by several concerns in Germany and engines of this kind are being built. Such injection has been used in the first place in hot-bulb engines and is satisfactory for that type. It has been extensively used, however, for Diesel engines by the Vickers concern.

The author does not appear to be in favor of the solid-injection method and gives the following comparison between solid injection and compressed-air injection as calculated for a 1700-hp. submarine-type four-stroke-cycle Diesel engine. In the case of compressed-air injection, an air-fuel volume of 75 cc. (4.57 cu. in.) has to be delivered, per cycle and injection needle, whereas in solid injection there is handled only a volume of 3 cc. (0.18 cu. in.), or one twenty-fifth that in the previous case. But, in the first place, the velocity of injection is in the neighborhood of 300 m. (984 ft.) per sec., and if with solid injection the same constant-pressure diagram is to be obtained, the same amount of fuel has to be injected at the same velocity; and the cross-section of the nozzle must also be only one twenty-fifth that of a corresponding compressed-air injection nozzle, which means that instead of the six nozzles of 2.2 mm. (0.085 in.) diameter used in air injection, there have to be six nozzles likewise used with 0.45 mm. (0.018 in.) in diameter, and in order to introduce the fuel at the same velocity as in the previous case the pressure on the fluid must be somewhere in the neighborhood of 300 atmos. The author claims that the introduction of very small volumes of fuel used makes it an extremely difficult problem to operate at such extremely high pressures.

The author further claims that the difficulties of materializing such high injection pressures are apparent in the Vickers engine in the complicated appliances used for solid injection. Thus, each of the twelve cylinders has its own fuel pump which, with its regulating devices and manometer, is as wide as the cylinder itself. If one should compare a Vickers 12-cylinder engine with a German U-boat-type four-stroke-cycle engine likewise of 1200 hp. but with six cylinders, it is easy to see how tremendously the difference in the method of injection affects the engine design; and the author fails to see in what way the elimination of an air compressor does anything to simplify the design, particularly as the use of a three- or four-stage compressor would make its operation quite simple.

The author is not aware of any published indicator diagrams of any precision covering the operation of solid-injection engines except the diagrams which appeared in *The Engineer* for Nov. 14, 1919, and apply to a submarine-type Vickers engine. The author compares these diagrams with similar diagrams obtained from a 1700-hp. U-boat engine built at the Germania Works in Germany. His criticism of the Vickers diagram (Fig. 1) is of interest.

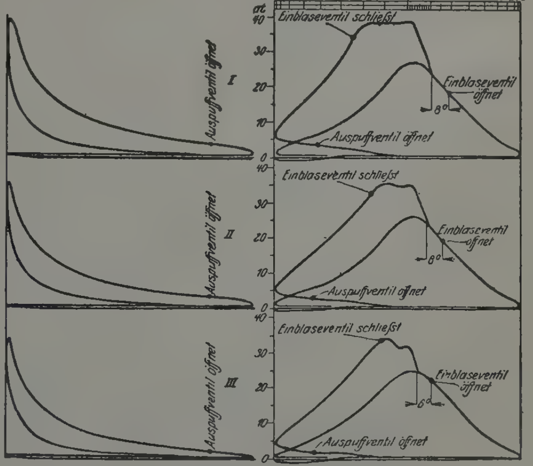

Fig. 1 Indicator Diagrams of a Vickers Submarine-Boat Type Engine with Solid Injection

(*Auspuffventil oeffnet*, exhaust valve opens; *Einblaseventil schliest*, inlet valve closes; *Einblaseventil oeffnet*, inlet valve opens; *Auspuffventil oeffnet*, exhaust valve opens; *at*, atmospheres; *TP*, dead center.)

Table 1 Data Referring to Diagrams in Fig. 1

Diagram No.	R.p.m., n	Pressure, Kg. per Sq Cm. p_i	Output, I.hp.	Fuel-Injection Pressure, Kg. per Sq. Cm.	Fuel-Injection Valve: Duration of Opening, Deg.	Fuel-Injection Valve: Begining of Opening, Deg. Ahead of Dead Center	Beginning of Pressure Rise after Valve Opening: Deg.	Beginning of Pressure Rise after Valve Opening: Seconds
I......	358	6.7	107	302	43	18	8	0.0037
II......	312	5.4	76	175	33	16	8	0.0043
III......	182	4.5	36	84	21	10	6	0.0055

The compression is set at 25 atmos. The explosive character of the combustion is indicated by the substantial rise in pressure during the injection of the fuel. The pressure under which the fuel is introduced is in the first full-load diagram at a level somewhat exceeding 300 atmos. or just about the values computed above. Properly timed introduction or governing of fuel injection, such as one is accustomed to in compressed-air-injection engines, is out of the question here. Furthermore, the low compression cannot be used for computing the dimensions of the parts, such as baseplate, crankshaft, cylinder or cylinder cover, and therefore it is impossible to secure a low-weight engine, this being due to the fact that the compression pressure in low-compression, solid-injection engines rises to the same levels as in compressed-air-injection engines having a compression of from 30 to 33 atmos. Moreover, as is shown by the behavior of the expansion line with partial load, there is a strong after-combustion. It is difficult to understand how under these conditions the Vickers engine can secure the fuel combustion of 170 grams per hp-hr. (0.374 lb.) claimed for it by the makers—all the more so as apparently smokeless combustion is not secured. In proof of this latter statement, the author quotes the following passage from an article by an English submarine-boat officer (*Motorship and Motorboat*, 1919, p. 175).[1] "They (meaning the Vickers engine) have, however, an important disadvantage, namely, they develop clouds of smoke which stretch for miles behind the submarine. The engines also *vibrate*, no matter how carefully they may be adjusted, and if the personnel in the engine room is not very careful, they may easily produce a smoke-screen effect."

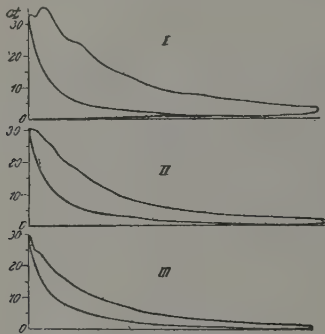

Fig. 2 Indicator Diagrams of a 1700-hp. U-Boat 4-Stroke Cycle Engine of the German Germaniawerft

For purposes of comparison, indicator diagrams are reproduced in Fig. 2 which were taken under approximately the same conditions in respect to speed in revolutions and average compression from a 1700-hp. German U-boat engine with compressed-air injection. Here, apparently, explosive combustion and the sudden pressure rise which accompanies it are completely eliminated, and the after-burning effect is comparatively slight.

The author comes to the conclusion that solid injection is suitable only for engines with a comparatively small output per cylinder and operating at fairly constant speed and load. For high-efficiency engines of large output, the solid-injection process must be considerably improved before it can enter into competition with compressed-air injection, and even then it is claimed by the author to have no advantage as compared with the Steinbecker process, which also operates without a compressor.

Table 2 Data Referring to Diagrams in Fig. 2

Diagram No.	R.p.m., n	Pressure, Kg. per Sq. Cm. p_i	Output I.hp.	Fuel-Injection Pressure, Kg. per Sq. Cm.
I	377.6	8	431	85
II	295.8	5 3	179	55
III	239	3.5	109	45

The main features of this process have already been described. Essentially, it consists of the following: A fuel pump located in the cylinder cover injects the fuel into a special passage about 3 deg. before dead center. A part of the fuel together with air enters a special chamber or retort filled with highly preheated air having a pressure of 30 atmos., which is several atmospheres below the compression pressure and is ignited there so that the pressure reaches 65 atmos. This pressure rise in the retort produces a powerful injection of the fuel into the main cylinder, and it is claimed that the action of this case is better than with solid injection, and the compression as good as with compressed-air injection, while the elimination of the compressor, the fuel-injection valve and the injection compressed-air tank with its valves and accessories are of course of material benefit.

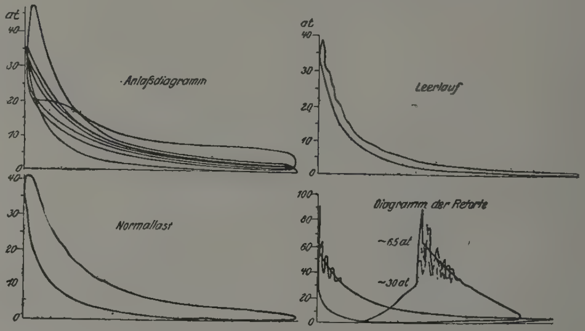

Fig. 3 Indicator Diagrams of an Experimental Steinbecker Diesel Engine

(*Anlassdiagram*, starting curve; *Normallast*, normal load; *Leerlauf*, idling; *Diagram der Retorte*, indicator diagram for the "retort;" *at*, atmospheres.)

In Fig. 3 are given four diagrams taken on an experimental engine of the Steinbecker type. It is claimed that the combustion was smokeless throughout.

The rest of the article discusses the subjects of vaporization, ignition, and combustion. These may be abstracted in an early issue. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, no. 33, Aug. 14, 1920, pp. 637–643, 13 figs., *tc*)

Heat Transfer in Flues

Heat Transfer in Flues, Lawford H. Fry, Mem.Am.Soc.M.E. Discussion of the laws governing heat transfer in flues, with particular application to locomotive-boiler flues.

The present article is an extension of a former article by the author in *Engineering* for Feb. 19, 1909, and a paper read before The American Society of Mechanical Engineers in 1917 (Trans.Am.Soc.M.E., vol. 39, p. 709), and is based on recent work of the author and others.

The rate of heat transfer is studied in its relation to the various factors on which it depends. These factors are:

1. *Temperature.* The rate of heat transfer depends on the ratio of the temperature of the gas to the temperature of the flue wall. If the flue wall has a mean temperature t, and if the mean gas temperature at one section of the flue is T_1 and at another section x ft. distant along the flue is T_2, all temperatures being measured from absolute zero in any scale, the relation between the two gas temperatures is given by the equation:

$$\text{lolog } T_1/t - \text{lolog } T_2/t = Mx \qquad \ldots\ldots\ldots\ldots [1]$$

where "lolog" means "the logarithm of the logarithm," and where M is a constant for a given set of conditions, being determined by the dimensions of the flue and by the rate of gas flow.

2. *Flue Dimensions.* The two dimensions on which the above constant M (and hence the rate of heat transfer) depends, are the perimeter and the mean hydraulic depth. The mean hydraulic depth is the area divided by the perimeter, and in a circular flue

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[1] Passage retranslated into English from the German, as the original publication is not available.—Editor.

is one-fourth of the diameter. When circular flues only are under consideration it is simpler and equally accurate to speak of the effect of the flue diameter instead of the effect of the mean hydraulic depth. This will be done in the present article, the symbol d being used to represent the flue diameter in inches. If the equations thus established are to be applied to annular or other non-circular flues, it is only necessary to replace d by $4h$, where h is the mean hydraulic depth.

3. *Rate of Flow of Gas.* The effect of the rate of gas flow on the rate of heat transfer is dependent on the weight of gas flowing per hour per inch of flue perimeter. Expressed in symbols this statement is to the effect that the coefficient M in Equation [1] varies with the ratio W/p, where W is the weight of gas flowing in pounds per hour and p is the flue perimeter in inches.

The relation between the flue dimensions, the rate of gas flow and the coefficient M is that given by the following equations:

$$\log M = B - m \log W/p \ldots\ldots\ldots\ldots [2]$$

where

$$\log (B + 1.3) = \bar{1}.71 - 0.54 \log d \ldots\ldots\ldots [3a]$$

and

$$\log m = \bar{1}.36 + 0.37 \log d \ldots\ldots\ldots\ldots [3b]$$

The derivation of these equations from the experimental data is discussed below, but attention is first directed to the conditions of heat transfer disclosed by the formulæ.

Equations [2], [3a] and [3b] show that for a given flue with gas flowing at a constant rate, the coefficient M in Equation [1] is a constant. This means that if distances along the flue x are measured from a point at which the gas temperature is T, the gas temperature T_1 at any other point is given by equation:

$$\text{lolog } T/t = \text{lolog } T_1/t - Mx \ldots\ldots\ldots\ldots [1a]$$

This is to say, the logarithm of the logarithm of the ratio of gas temperature to flue temperature (lolog T/t) falls by a straight-line law along the flue. The slope of the line giving this fall of the lolog of the temperature ratio is measured by the coefficient M.

This equation enables determining the heat transfer from gas to flue in any section of the flue by finding the temperature loss of the gas.

Furthermore, the form of Equation [1a] indicates that a large value of M corresponds to a rapid drop of temperature along the flue, that is, a rapid rate of heat transfer.

Table 1 shows how the value of M is affected by the three factors on which it depends, namely, flue diameter, flue perimeter and rate of gas flow. Another table (Table 2) in the original article is given to show the length of flue necessary to reduce the gas temperature from an initial value of 2000 deg. to 720 deg. fahr. with a flue-wall temperature of 380 deg. and from this table it appears that with a $^1/_2$-in. flue the above temperature drop will take place in 3.76 ft. of pipe with a flow of 100 lb. per hour, while a length of 6.15 ft. will be required for the same temperature drop with a flow of 1600 lb. per hour. This is particularly significant as in the first instance the heat transferred from gas to flue is equal to 41,800 B.t.u. per hour, while in the second case the rate of heat transfer will be 16 times as great, or 668,800 B.t.u. per hour.

TABLE 1 VALUE OF COEFFICIENT M FOR VARIOUS FLUE DIAMETERS AND RATES OF GAS FLOW

	Values of W				
In.	100 Lb./Hr.	200 Lb./Hr.	400 Lb./Hr.	800 Lb./Hr.	1600 Lb./Hr.
0.5	0.133	0.117	0.104	0.092	0.081
1.0	0.074	0.063	0.054	0.046	0.039
2.0	0.050	0.040	0.033	0.027	0.022
4.0	0.040	0.030	0.023	0.018	0.014
8.0	0.037	0.026	0.019	0.013	0.009

From the data given in Table 1 it would appear that the rate of heat transfer falls off rapidly as the flue diameter is increased. Other tables are given showing the temperature drop and the amount of heat transferred in flues 5 ft. long when the flue diameter and rate of gas flow are varied. These tables show clearly the effect of increasing flue diameter on increasing the final temperature, that is, on reducing the amount of heat transfer, while the other tables illustrate the effect on the heat transfer of varying the flue length, flue diameter, rate of gas flow and the gas temperature as well as the temperature of the flue wall.

In order to facilitate the use of the formulæ Tables 2 and 3 are given, of which the former gives for various flue diameters the intermediate coefficients m and B which are used in establishing the coefficient M, while Table 3 gives values of the coefficient M for a number of flue diameters and rates of gas flow. The relation of m and B to the flue diameter is given by the Equations [3a] and [3b]; the values of coefficient M given in Table 3 are calculated from Equation [1], where W is the weight of gas in lb. flowing per hour and p is the flue perimeter in inches.

TABLE 2 VALUES OF COEFFICIENTS m AND B FOR FLUES OF VARIOUS DIAMETERS

d In.	B	m	d In.	B	m
0.38	$\bar{1}.561$	0.160	1.50	$\bar{1}.112$	0.266
0.44	$\bar{1}.500$	0.169	2.0	$\bar{1}.053$	0.296
0.50	$\bar{1}.444$	0.178	2.25	$\bar{1}.031$	0.309
0.58	$\bar{1}.388$	0.188	2.5	$\bar{1}.013$	0.321
0.66	$\bar{1}.341$	0.197	3.0	$\bar{2}.983$	0.342
0.75	$\bar{1}.300$	0.208	3.5	$\bar{2}.961$	0.364
0.87	$\bar{1}.253$	0.218	4.0	$\bar{2}.943$	0.382
1.00	$\bar{1}.213$	0.229	5.0	$\bar{2}.915$	0.415
1.15	$\bar{1}.175$	0.242	6.0	$\bar{2}.895$	0.445
1.30	$\bar{1}.145$	0.252	8.0	$\bar{2}.867$	0.494

The data presented above were obtained by the use of methods described in the author's paper in Trans.Am.Soc.M.E., vol. 39, 1917, p. 709, in which he surveyed some of the experimental work done on heat transfer between the gas and the flue and derived experimental formulæ. As he stated, he had tried to harmonize some of the various groups of experiments without success until Hedrick and Fessenden put forward their double logarithmic (lolog) formula (Trans.Am.Soc.M.E., vol. 38, 1916, p. 407). The use of an expression of this type led to the formulæ which have been given above and which give a much wider range than any previous expressions for heat transfer.

The formulæ given by the writer are based on the experiments of Jordan, Nusselt, Josse, The Babcock & Wilcox Company, and Fessenden. In addition to these, the author analyzed five series of boiler tests, two of which were made by the Pennsylvania Railroad with locomotive boilers and the other three with stationary boilers—one by Nicolson on an experimental plug-type boiler, the second by the Bureau of Mines on a Heine boiler, and the third on a return-type boiler. (*Engineering*, vol. 110, no. 2852, Aug. 27, 1920, pp. 265–268, 5 figs., *teA*)

TABLE 3 VALUES OF COEFFICIENT M

Pounds of Gas per Inch of Perimeter per Hr.	d = Inside Diameter of Flue in Inches																
W/p	0.38	0.44	0.50	0.58	0.66	0.75	0.87	1.00	1.15	1.30	1.50	1.75	2.00	2.25	2.50	3.00	3.50	4.00
2.00	0.326	0.281	0.246	0.215	0.1915	0.1725	0.1540	0.1390	0.1265	0.1170	0.1080	0.0986	0.0920	0.0866	0.0824	0.0758	0.0710	0.0673
2.83	0.310	0.265	0.231	0.201	0.1790	0.1603	0.1420	0.1290	0.1165	0.1075	0.0985	0.0895	0.0831	0.0780	0.0738	0.0674	0.0625	0.0589
4.00	0.292	0.250	0.217	0.188	0.1670	0.1493	0.1320	0.1190	0.1070	0.0983	0.0897	0.0811	0.0750	0.0700	0.0659	0.0598	0.0551	0.0517
5.86	0.276	0.236	0.204	0.176	0.1563	0.1390	0.1225	0.110	0.1009	0.0901	0.0818	0.0736	0.0677	0.0630	0.0590	0.0532	0.0485	0.0452
8.00	0.261	0.222	0.192	0.166	0.1460	0.1290	0.1135	0.1015	0.0903	0.0826	0.0746	0.0667	0.0611	0.0565	0.0527	0.0472	0.0427	0.0396
11.3	0.246	0.210	0.180	0.155	0.1360	0.1205	0.1053	0.0935	0.0851	0.0756	0.0680	0.0592	0.0552	0.0507	0.0472	0.0420	0.0377	0.0347
16.0	0.233	0.198	0.169	0.145	0.1270	0.1120	0.0974	0.0864	0.0763	0.0693	0.0621	0.0548	0.0498	0.0455	0.0422	0.0372	0.0332	0.0304
22.6	0.221	0.186	0.159	0.136	0.1187	0.1043	0.0903	0.0800	0.0703	0.0635	0.0566	0.0498	0.0450	0.0409	0.0378	0.0331	0.0292	0.0266
32.0	0.209	0.176	0.150	0.127	0.1110	0.0970	0.0837	0.0738	0.0645	0.0582	0.0516	0.0451	0.0405	0.0367	0.0338	0.0294	0.0258	0.0233
45.2	0.198	0.166	0.141	0.119	0.1035	0.0903	0.0776	0.0682	0.0594	0.0533	0.0471	0.0409	0.0366	0.0329	0.0303	0.0261	0.0227	0.0200
64.0	0.187	0.157	0.133	0.112	0.0965	0.0840	0.0720	0.0631	0.0546	0.0489	0.0430	0.0371	0.0329	0.0296	0.0270	0.0232	0.0200	0.0174
90.5	0.177	0.148	0.125	0.1047	0.0903	0.0781	0.0667	0.0583	0.0502	0.0448	0.0392	0.0336	0.0305	0.0265	0.0242	0.0206	0.0176	0.0159
128.0	0.167	0.139	0.117	0.0981	0.0843	0.0727	0.0618	0.0538	0.0461	0.0410	0.0357	0.0305	0.0268	0.0239	0.0217	0.0183	0.0155	0.0137
181.0	0.158	0.131	0.110	0.0918	0.0788	0.0677	0.0573	0.0498	0.0425	0.0376	0.0326	0.0276	0.0242	0.0215	0.0194	0.0162	0.0137	0.0127
256.0	0.150	0.124	0.104	0.0861	0.0736	0.0630	0.0531	0.0459	0.0390	0.0344	0.0297	0.0250	0.0219	0.0193	0.0173	0.0144	0.0120	0.0106
362.0	0.142	0.117	0.0974	0.0807	0.0688	0.0586	0.0492	0.0425	0.0359	0.0315	0.0271	0.0227	0.0198	0.0173	0.0155	0.0128	0.0106	0.0092
512.0	0.134	0.110	0.0916	0.0756	0.0642	0.0546	0.0456	0.0392	0.0329	0.0289	0.0247	0.0206	0.0178	0.0155	0.0139	0.0114	0.0094	0.0081
724.0	0.127	0.104	0.0862	0.0710	0.0601	0.0508	0.0423	0.0361	0.0303	0.0265	0.0225	0.0187	0.0161	0.0140	0.0124	0.0101	0.0082	0.0071
1024.0	0.120	0.098	0.0811	0.0665	0.0561	0.0473	0.0392	0.0334	0.0278	0.0242	0.0205	0.0169	0.0145	0.0125	0.0111	0.0090	0.0072	0.0062

Short Abstracts of the Month

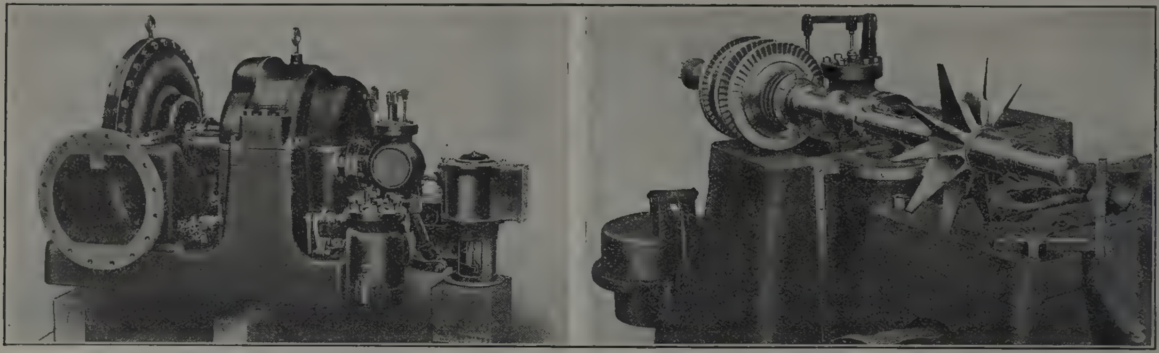
AIR MACHINERY (See Thermodynamics)

DeLaval Direct-Connected High-Speed Turbo-Blower

22,000-R.P.M. SINGLE-STAGE TURBO-BLOWER. In 1916 the Westinghouse Machine Company built a small blower designed to run at 43,000 r.p.m. which actually ran at speeds as high as 60,000 r.p.m. In one of the tests the rotor of this blower was damaged, and there is no information available whether it was ever actually placed on the market.

It has proved, however, that blowers running at these terrific speeds are fully practicable.

In this connection the unit recently built by the Rateau, Battu, Smoot Co. of New York City and described in *Power* is of particular interest. The unit was built for a South American mining concern and before shipment was operated at 26,000 r.p.m. for test purposes, but is intended for normal operation at 22,000 r.p.m. It is a single-stage turbo-blower which, when operating at its normal speed, will compress 3000 cu. ft. of free air per min. to 15 lb. per sq. in. Fig. 1 shows the complete unit assembly, with the turbine at the left.



FIGS. 1 AND 2 22,000-R.P.M. SINGLE-STAGE TURBO-BLOWER

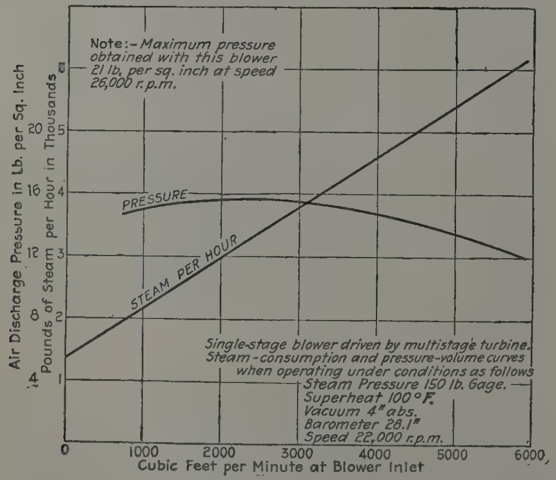


FIG. 3 PERFORMANCE CURVES OF TURBO-BLOWER OF FIG. 1

In the turbine the rotor has three wheels which are machined as an integral part of the shaft which is made of a nickel-chrome-magnesium steel, heat-treated forging, the radial blades being machined as an integral part of the shaft. Fig. 2 shows the rotor removed from the bearing and resting on the lower half of the casing. The 6-in. rule standing vertically on the right-hand end of the casing gives an idea of the size of the rotor, which weighs only 138 lb., of which 100 lb. is in the turbine rotor, and only 38 lb. in the blower rotor.

The rotor had to be made of a single piece in order to give it the maximum rigidity. It is so designed that at all points the stresses are far below the elastic limit of the metal. In machinery running at the high speeds employed in this case (at 26,000 r.p.m. the tip speed of the blower rotor is 1400 ft. per sec., or greater than the velocity of sound) centrifugal forces become of extreme importance, as one ounce weight on the end of the blade exerts a radial pull of approximately 3.75 tons.

Fig. 3 gives some data as to the normal performance of the turbine and blower as shown by the elaborate tests made before shipment. An interesting feature of the operation is that at full speed and overspeeds the machine operated without the slightest variation. The results of these tests also show that two machines of this type working in series can be made to compress air to 100 lb. pressure in small units, and three machines in series would give a compression as high or higher than 100 lb. for large-size machines. (*Power*, vol. 52, no. 9, Aug. 31, 1920, pp. 327–328, 4 figs., *d*)

BUREAU OF STANDARDS

AIR FORCES ON CIRCULAR CYLINDERS, AXES NORMAL TO THE WIND, WITH SPECIAL REFERENCE TO DYNAMICAL SIMILARITY, Hugh L. Dryden. One of the most difficult problems of the airplane designer is to obtain a method of computing forces on full-size machines or full-size machine parts from measurements made on models in a wind tunnel. A certain equation deduced from theoretical considerations has long been known and used, namely, the equation proposed a long time ago, first by Helmholtz, later stated by Reynolds, and developed more fully by Lord Rayleigh and Buckingham. This equation is a logical consequence of certain assumptions and states that, if these assumptions are true, the force of a current of air upon a solid body may be expressed as $C\rho AV^2$, ρ being the density of the air, A the area of the body projected on a plane normal to the wind, V the velocity of the wind, and C a dimensionless constant depending on a single parameter VL/ν, where ν is the kinematic viscosity of the air and L is a linear dimension of the body. This equation then implies that if C be plotted against VL/ν, the points will fall on the same curve independent of the individual value of V or L provided the bodies are geometrically similar and presented in the same manner to the wind.

This law is a logical consequence of the assumptions. Although some tests have been made of the validity of the assumptions in the case of wind-tunnel experiments, no extensive investigation of a body of simple geometrical form over a large range of values of V and L has been published. The present paper gives the results of tests on cylinders for different values of L. An attempt was made to make the assumptions involved in the derivation of the equation true as closely as is possible in wind-tunnel experiments.

Cylinders of 1, $1^1/_4$, $1^1/_2$, $1^3/_4$, 2, $2^1/_2$, 3, 4, $4^1/_2$, 5, $5^1/_2$ and 6 in.

(0.0254 to 0.1524 m.) were used at velocities from 15 to (in the case of the smaller cylinders) 80 m.p.h. (25 to 130 km. per hour, approximately). The range of values of VL/ν was from 10,000 to 185,000. The cylinders were made of wood with the exception of those less than 2 in. in diameter, which were in brass; but an additional 1-in. wood cylinder and 4-in. brass cylinder were also used. The "guard ring" principle was used to obtain results applicable to infinite cylinders.

The results show that the equation does not represent the facts of wind-tunnel experiments in the case of cylinders. The coefficient C for a 1-in. cylinder is half again as large as that for a 3-in. cylinder at the same value of VL/ν. Above a 3-in. diameter the equation is satisfied closely, the coefficient being practically constant and equal to 0.426. The curve for the 1-in. cylinder checks N.P.L. values closely. The maximum departure of any one observation from the mean is about $2^1/_2$ per cent. Measurements of the pressure distribution showed that in the case of the small cylinders the ratio of the average decrease in pressure on the back to the maximum increase in pressure on the front is greater than in the case of the large cylinders. (Abstract of *Scientific Paper of the Bureau of Standards*, no. 394, *t*)

Cast Iron for Locomotive-Cylinder Parts, C. H. Strand. Frequent removal of cylinder parts of locomotives results in greatly increased cost of maintenance to the railroads, and consequently the quality of the cast iron entering into their construction is a matter of paramount importance, particularly from the standpoint of wear. These parts include piston-valve bushings, piston-valve packing rings, piston-valve bull rings, cylinder bushings, piston packing rings and piston-head or bull rings. It was found that ordinary high-silicon cast iron gave unsatisfactory wear, particularly in modern superheater locomotives, and the tendency has been toward a harder and stronger iron.

At the request of the U. S. Railroad Administration, the Bureau of Standards has investigated the mechanical, chemical, and microscopical properties of a number of packing rings furnished with service mileage records, as well as arbitration-test bars, chill-test specimens, and miscellaneous examples from different manufacturers. All of this material was cast iron such as used for the various cylinder parts. The Bureau of Standards at the same time made a review of the previous work and specifications on the subject, to ascertain as far as possible the practices of the different foundries, and to suggest such revision of existing specifications as would be warranted by the results of the present and other investigations.

It was found that air-furnace iron is made more uniform in character and in general of somewhat better mechanical properties than cupola iron. The latter, however, often equals or even excels the air-furnace product in mechanical properties. Because of the many variable factors, it was difficult to establish correlation between laboratory and service tests. It was recommended, as a result of the present and other investigations, that the transverse-strength requirements of the Standard American Society for Testing Materials $1^1/_4$-in. Arbitration Bar be increased from 3200 to 3500 lb. for castings $^1/_2$ in. or less in thickness, and from 3500 to 3800 lb. for castings over $^1/_2$ in. in thickness. (Abstract of *Technologic Paper of the Bureau of Standards*, no. 172, *e*)

ENGINEERING MATERIALS

The Influence of Copper, Manganese and Chromium and Some of Their Combinations on the Corrosion of Iron and Steel, E. A. Richardson and L. T. Richardson. Data of experimental work made upon steel both free from and containing copper, and upon commercial pure iron both free from and containing copper.

These tests brought out a number of deductions, some of which were known before. Steel rusts much faster than iron, but the presence of iron decreases the corrosion of both—more so, however, in the case of steel. It was further found that it was the manganese present in the steel, but not in the iron, which was intensifying the action of copper in reducing corrosion.

Of considerable interest are the remarks of the authors on pure iron. Hitherto the effort was to make manganese in pure iron intended for use as a rust-resisting material as low as possible. However, commercially pure iron contains about 0.04 per cent of copper, which causes it to be red-short. The addition of a small amount of manganese would make this iron slightly more rust-resisting and at the same time remove the tendency to be red-short, while the addition of still more copper and manganese would materially increase its rust-resisting properties.

The cause of the influence of copper on the corrosion of iron has never been satisfactorily explained. The present authors propose what they call the "film" or "intergrain" theory of corrosion resistance. This theory is based on the assumption that iron only becomes rust-resistant when certain impurities are present in certain amounts. Copper creates an intergrain rust-resisting film, which, on the other hand, also assists in creating red-shortness. A brief list of references covering previous research on corrosion, and especially influence of impurities, is appended in the original article. (Paper presented at the general meeting of the *American Electrochemical Society*, Cleveland, Ohio, Sept. 30–Oct. 2, 1920, pp. 123–135, 6 figs., *tp*. Abstracted through advance copy)

20-"Year" Tests of Cement and Mortar Materials

Long-Time Tests of Portland Cement, Hydraulic Lime and Volcanic Ashes, I. Hiroi. Data of two series of tests covering a period of more than 20 years. Some of the cements used for the first series of tests were manufactured by the old process of burning in so-called "bottled" kilns, while those in the second series were produced in modern rotary kilns. Another series of tests is also under way which it is proposed to extend over a period of 100 years.

The following are some of the conclusions arrived at by the author:

In sea water neat-cement briquets attained maximum strength in the course of less than a year, after which they rapidly declined, in some cases completely losing their tensile strength in four or five years. The author ascribes this peculiarity to excessive crystallization, which makes the structure highly brittle. While losing their tensile strength almost entirely, these briquets retain their form and also show considerable amounts of compressive strength, which latter, in fact, possibly even increases while the tensile strength decreases.

Cement-sand mortar mixtures in the proportion of one part of the former to two parts of the latter in air and sea water show progressive increase of strength with age, the air curves running much higher than sea-water ones. The mean results apparently follow more or less closely hyperbolic curves (for which equations are given in the original paper), which would place the eventually attainable tensile strength of such mortar in air and sea water at 85 and 50 kg. per sq. cm. (1210 and 710 lb. per sq. in.), respectively.

Tests were also made to determine the influence of the kind of sand used for mortars, and it was found that while standard and coarse sands produced practically equal strength, fine sand was found to be decidedly inferior in air, fresh water and sea water, both in tension and in compression.

As regards the strength of mortars in sea water, it was found that the lower the proportion of sand in the mortar the stronger the latter will be.

The results, however, have also suggested the possibility that in mortars to be used in sea water an excess of cement is to be avoided as much as a deficiency. A proportion richer than 1 : 1 is too costly and one lower than 1 : 3 may have voids; the proportion of 1 : 2, on the other hand, has little more cement than is sufficient to fill up all the interstices in the sand.

Tests on the effect of curing in fresh water on the strength of mortars kept in sea water have not indicated any definite and material improvement due to curing.

An interesting series of tests was made on the use of volcanic ashes in cements, the ashes used being of Japanese origin exclusively. In air tests it was found that the greater the amount of ashes used the lower the strength of the briquets, and none of the ash-cement mortars had a strength equal to that of the straight cement ones. On the other hand, in sea-water tests the superiority was decidedly on the side of the ash-cement mortars, which are, however, weaker than straight cement mortars in compression.

The action of volcanic ashes when used in a cement mortar appears to be twofold, viz., mechanical and chemical. Mechanically, the ashes increase the density of the mixes, making the latter more or less impermeable to sea water; chemically, the combination of silica with free lime in cement, which makes the latter unassailable by the sulphates contained in sea water, seems to be the most important action. The activity of silica contained in ashes naturally depends on the state in which it is present; and while there is no doubt that the soluble portion is the most active agent, the total amount of silica should also be taken into consideration. Thus, the Otaru ashes, which according to the analysis contain the least amount of soluble silica of the three but the largest amount of the insoluble one (on an average of 61 per cent in the Otaru ashes, 47 per cent in the Yoichi, 34 per cent in the Goto), produced higher strength than either of the other two ashes. That a portion of insoluble silica enters into combination to form soluble compounds in course of time is shown by the several analyses made of (Otaru) ash-cement mortar block kept in sea water, the results of which are given in the following table:

	Silica (Total 100)	
Time of Analysis	Soluble	Insoluble
Before induration	43.73	56.27
2 months	46.28	53.72
7 months	47.29	52.71
14 months	50.08	49.92
38 months	53.95	46.05

The value of volcanic ashes, as an ingredient in a cement mortar is possible of direct determination by testing the combining power of the ashes with lime. (*Journal of the College of Engineering, Tokyo Imperial University*, vol. 10, no. 7, 1920, pp. 155–172 and 10 plates, *e*)

FUELS AND FIRING

German Pluto Stoker and Its Improvements

Development of the Pluto Stoker for the Utilization of Low-Grade Fuels, Otto Nerger. While attempts were made in Germany and Austria before the war to utilize the poorer grades of fuel, it was under the pressure of war conditions that a really earnest effort was made in this direction. Among the poorer grades of fuel available for industrial use on a large scale by the Central Powers are, first, the waste products of the coal mines, such as coal dust, breeze, products of coal washing, coke breeze and coke ashes. Next to this come such low-grade coals as lignite and peat, the latter fuel being largely in a class by itself, however.

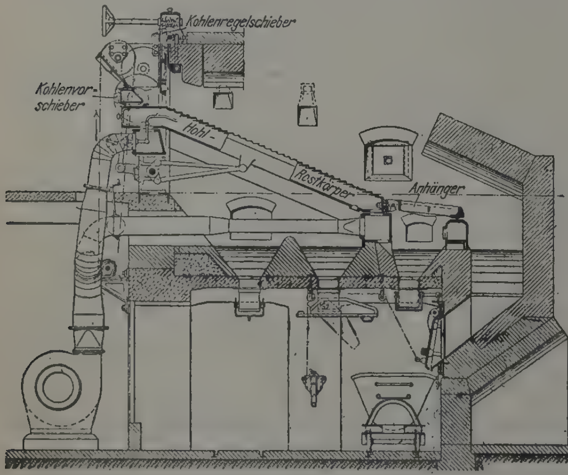


Fig. 4 Early Design of Pluto Stoker

(*Kohlenregelschieber*, slide plate to govern rate of supply of coal; *Kohlenvorschieber*, slide plate to govern supply of fresh coal to fuel bed; *Hohlrostkörper*, hollow grate bars; *Anhänger*, rocking slag grate.)

All of these low-grade fuels require special appointments for their utilization, depending to a certain extent on the moisture and ash contents of the fuel, but above all on the content of volatile matter in the fuel, which latter ultimately determines whether the fuel can be utilized at all.

Among other things, low-grade fuels require special grates, and in Germany forced-draft traveling grates were chiefly used, while in Austria and Hungary preference was given to the so-called Pluto stoker.

A Pluto stoker of old design is shown in Fig. 4. Its chief characteristic was the use of a massive hollow grate body and rigid side walls. Early users often found that the hollow grate bars did not last very long and that the fire on them could not be well maintained. In later years, however, improvements made in the design largely eliminated this source of trouble, and it was found that some of the early troubles were due chiefly to the fact that the amount of draft available in the furnaces was entirely insufficient, which led to improper combustion and rapid deterioration of the grate bars.

It is claimed that in those early days there existed an erroneous impression that the availability of forced draft made the further and more important action of the smoke stack unnecessary, which is, however, incorrect, as the action of the forced draft can hardly be sufficient to overcome the resistance of the fuel bed and to produce a slight vacuum in the fire chamber. Even then the question of carrying off the gases of combustion without material turbulence remains still to be taken care of.

In an effort to remedy as far as possible the troubles in the hollow grate bars indicated above, an attempt was made to produce what the original article calls a "removable grate," which makes it possible to take out particularly badly attacked parts of the grate surface and to replace them by fresh elements at a comparatively low expense. Fig. 5 shows such a grate with removable bars. From this it appears that the general shape of the grate has not been changed, but that each section consists of a frame and grate elements inserted therein. This construction has also been of advantage because the bending of the massive hollow grate bars used in the older structure has disappeared in the new, and it is claimed that the new type of grate, of which many thousands were installed during the last five years, has proved to be more economical from the point of view of replacements than chain grates. This is due to the fact that in the Pluto stoker it is only the inserted elements in the firing zone that have to be replaced from time to time, while the frame and other parts are subject to practically no wear.

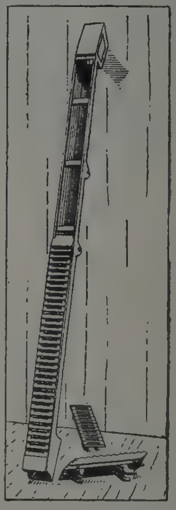


Fig. 5 Pluto Stoker Grate with Removable Bars

In order to reduce as much as possible the dropping through the grate of unconsumed combustible material, the rigid side walls of the older grate were replaced by a springy, adjustable structure such as is shown in Fig. 6. From this it would appear that the structure maintains its adjustment at all times because the springs are located not at the level of the combustion chamber, but in the comparatively cool ashpit. Furthermore, the arrangement of the parts is such that there is always an opportunity to tighten up the springs even while the furnace is being operated.

In many types of furnace it has been found that the residues of combustion clinker together on the short and rigid ash grate and can be removed only by knocking them off with bars through sidewise-located openings. This trouble has been encountered quite often, particularly with fuels inclined toward the formation of clinkering slags. To obviate this the usual rigid plane grate has been replaced by a suspended traveling grate, the construction of which may be seen in Fig. 4. This suspended grate is connected to the hollow bar grate by means of a hinge and, therefore, goes through the same motions as this latter. Because of this the slags are never at rest and have no opportunity to clinker.

Furthermore, the use of the movable suspension grate has the advantage that by the simple displacement of a rear grate support the angle of inclination of the grate may be varied, which, in its turn, varies the rate of sliding of the fuel. In the case of coals of lower ignitibility, which require a longer time for complete combustion, a very slow rate of travel may be secured by an appropriate variation in position of the suspended grate.

A further improvement as compared with the type which was at first used in Germany, consists in the use of a so-called water-column motor with worm-gear drive. This motor is attached to the boiler feed line and makes it possible to vary the rate of travel of the grate within wide limits by throttling more or less the water-admission valve. Furthermore, this type of water-column motor has no fast-moving parts and no uneconomical ratio of speed transformation. It simply transmits the up-and-down movement of the piston directly to the oscillating stoker shaft by means of a connecting rod. The water-column motor replaces not only the electrical driving motor but also transmission and governing devices. Tests made with this type of motor have shown that the duration of a double stroke of the stoker shaft can be varied at pleasure from 8 to 80 sec. by proper adjustments on the motor. The details of this motor are not shown in the original article. (*Stahl und Eisen*, vol. 40, no. 29, July 22, 1920, pp. 969–975, 8 figs. and one large table, *de*)

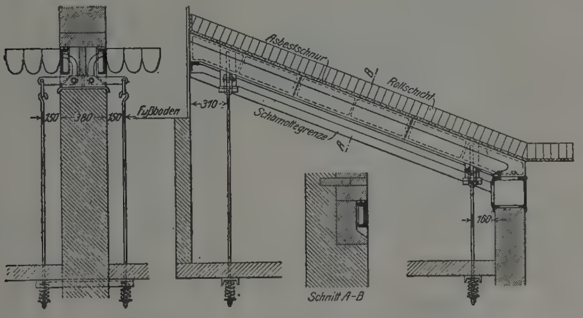


Fig. 6 The Side Walls of a Pluto Stoker with Spring Automatic Adjustment

(*Fussboden*, floor; *Asbestosschnur*, asbestos winding; *Schnitt A-B*, section through A-B; *Schamottengrenze*, edge of refractory clay.)

FUELS AND FIRING

Fuel-Economy Report of the British Association. Abstract of the third report of the Committee (Prof. W. A. Bone, Chairman) appointed for the investigation of fuel economy, utilization of coal, and smoke prevention, presented to Section B at the British Association Meeting on Aug. 26. The report gives a considerable amount of data on coal mining and export statistics which cannot be abstracted here, also on future gas standards and alcohol from coke-oven gas.

As regards the gas standards, the Committee looked at the question primarily from the point of view of the national interests as a whole, and particularly from that of domestic and industrial gas consumers. It agreed with the Fuel Research Board that the future basis of charge to the consumer should be the actual number of thermal units supplied to him in the gas which passed through his meter, but desired that the charge should be based upon the "ascertained net calorific value" of the gas supplied rather than its "declared calorific value" as proposed by the Fuel Research Board.

As regards the gas pressure, the Committee recommended not less than 2 in. of water at the exit of the consumer's meter and not any measure of pressure in the mains or service pipes, taking the stand that what mattered to the consumer was the adequacy of the pressure in his pipes rather than in the gas mains outside his premises. The Committee attached great importance to the pressure being maintained as constant as possible, as well as to the requirement that greater attention than ever be paid to the removal of cyanogen and sulphur impurities from the gas.

In this connection some data are mentioned from the Gas Regulation Bill, now under consideration in the British House of Commons. Among other things, this bill introduces a new unit for the sale of gas, namely, the "therm," equal to an amount of gas containing 100,000 B.t.u.

As regards the production of alcohol from coke-oven gas, it is stated that the trials made at the Skinningrove Iron Works have demonstrated the possibility of obtaining on a large scale 1.6 gal. of absolute alcohol per ton of the Durham coal used in the tests. For data on the Skinningrove process see Mechanical Engineering, June 1920, p. 352. (*The Engineer*, vol. 130, no. 3374, Aug. 27, 1920, pp. 196 and 198, *g*)

HYDRAULICS

Flow of Oil in Pipes, Arthur C. Preston. Discussion of the flow of viscous liquids in pipes, having for its aim the development of a method for determining frictional loss as a function of the viscosity and density of the liquid. The flow of mineral oils is primarily considered, but the method is general and may be applied to other fluids. The author claims that the rate of flow of liquid moving through a pipe under a gravity head is influenced by three characteristics of the liquid itself: namely, the density which supplies the pressure-producing flow, the viscosity which retards flow, and inertia, which, under certain conditions, manifests itself in the dissipation of energy by the collision of eddying particles. These three constitute what may be called the internal group of factors affecting flow, while such factors as diameter, length, and roughness of the pipe and the amount of gravity head are external factors and secondary in the order of consideration of the problem as a whole.

Hydraulic tables are claimed to be incapable of furnishing a satisfactory basis for estimating the flow of one liquid when the flow of another has been determined by the same pipe. On the other hand, when a general solution for the problem of liquid flow is obtained, it takes the place of hydraulic formulæ and gives the same results simply by substituting in the general formulæ the physical dimensions of the pipe and the values for the particular density and viscosity of the liquid flowing, such as water.

The first part of the article, which is all that has been published so far, is devoted to a discussion of the questions dealing with the viscosity of the liquid. One of the conclusions to which the author comes is that liquids of equal Saybolt viscosity have equal pipe-friction losses, at least through the range of velocity in which flow is steady and also for all higher velocities. (*Chemical and Metallurgical Engineering*, vol. 23, no. 13, Sept. 29, 1920, pp. 607–612, 3 figs., *tA*)

MACHINE TOOLS

Sonic Wave-Power Tools

Dorman Wave-Power Tools. In Mechanical Engineering, June 1920, p. 359, an abstract was given dealing with the Constantinesco sonic waves and the method of power transmission by rapid impulses in liquids.

Information about this novel method has been scarce and not easily obtainable. The method itself was invented by George Constantinesco, a Roumanian engineer, and was in the early stages of development in England when the world war broke out. As soon as this happened the British government took over the experimental work and made the patents secret under the Defense of the Realm Act. This secrecy was maintained to such an extent that even Walter Haddon, a prominent British manufacturer and associate of the inventor, was forbidden access to his own works, W. H. Dorman & Co., Ltd., and refused information regarding results obtained.

The necessity of such secrecy was due to the fact that the wave-transmission method was early applied to the C.C. gear for the automatic firing of guns on aeroplanes.

Since the close of hostilities, W. H. Dorman & Co., Ltd., restored to the use of their patents, have been at work in the development of power transmission by wave motion and the tools necessary for its application. The following information is obtained from a publication issued by the company, under the title Dorman Wave Power Tools, this source of information being used in this case because of the fact that no other source is available. For the principles of the method, reference is made to the abstract in the June issue of MECHANICAL ENGINEERING referred to in the first paragraph.

The wave-transmission installation consists of three units corresponding to dynamo, transmission line and motor in electrical installations. The first of these units is a wave generator, which consists of one or more metal cylinders, each fitted with a piston connected by a crankshaft to some high-speed prime mover such as a steam or internal-combustion engine, or, considered for this particular purpose, an electric motor; second, a wave-transmission pipe line which may be either rigid or flexible and in which various kinds of fluids may be used, though the highest transmission efficiency is obtained with water; third, a wave motor, which consists of one or more metal cylinders, each fitted with a piston designed to receive the power wave at the intake end, the other end of the piston being suitably connected to the tool or mechanism desired to be operated. The simplest application is found in such appliances as rock drills and riveting hammers, where the piston is used as a floating hammer and strikes directly on to the shank end of the drill or rivet snap.

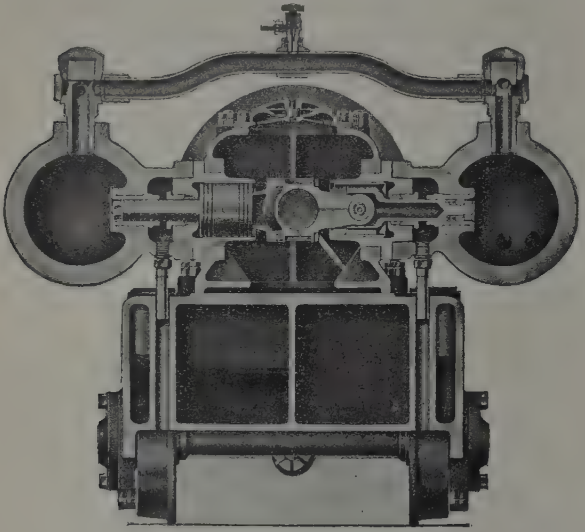


Fig. 7 Wave Power-Transmission Generator (Section through "Capacities")

Essentially, a wave generator is a pump, but since its purpose is not so much to convey the liquid as to convey it in a certain manner, that is, by impulses regularly following each other at predetermined intervals, it has some features not encountered in ordinary pumps. One of these is the so-called "Capacity," shown in Fig. 7. By "Capacity" in wave-transmission terminology is meant two spherical hollow steel castings designed to suit the pressures adopted. These are bolted to the crankcase and located by the crosshead guide. The disposition of these vessels on either side of the crankcase balances the forces of the crankshaft and insures freedom from vibration and quiet running at high speeds. The vessels are connected by a pipe at the top, the function of which is to equalize the pressure in each and enable the whole energy of the generator to be taken from either vessel. At the highest point of the balance pipe is a small needle valve for releasing any air which may get into the system. This is only required for a few seconds when starting up.

Screwed into the left-hand spherical vessel is an inlet charging valve actuated by pressure difference. When the minimum pressure in the capacity is greater than the pressure of the pump, it is closed. But immediately upon the pressure in the capacity being lower than the pump pressure (due to loss of water) it opens.

For the pipe line either rigid or flexible piping may be used. The construction of the Dorman flexible pipe is shown in Fig. 8. The individual sections are made from solid-drawn steel tube or other metal, with spherical joints at the ends. These joints consist of a piece of steel formed with a spherical recess at each end, into which fits a length of solid-drawn tube upon which is mounted a ball piece which accurately fills the spherical recess. The ball piece is flattened out on one end to receive the special packing ring made from materials suitable for the purpose for which the pipe is used.

A spherically seated nut screwed into the double socket shoulders against the spherical surface of the ball piece and holds the pipe together. It is claimed that this type of piping can be made for pressures up to 10 tons per sq. in. and also that it has been in constant use for the last three years under alternating pressure varying from about 1600 lb. per sq. in. down to atmospheric pressure, the pressure variations taking place between these two extremeties forty times per second without causing the slightest trouble.

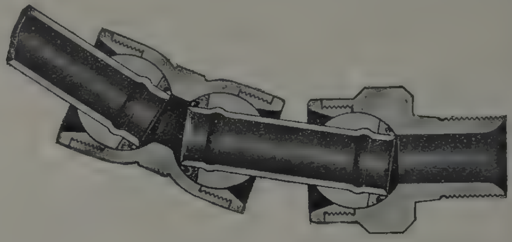


Fig. 8 Dorman Flexible Steel Pipe

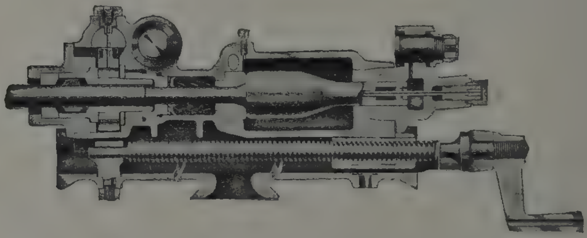


Fig. 9 Wave Power-Transmission Hammer-Type Rock Drill

The third element in the wave power-transmission system is the motor, but this is not shown in detail in the publication from which the present abstract is taken. The illustration in Fig. 9, however, will give an idea of the construction of wave-power tools, such as hammer-type rock drills. In this connection, it may be stated that for this type of hammer a rapidity of 2400 to 3000 blows per minute is claimed, which, it is said, gives a higher rate of penetration at a lower power consumption than is possible with the pneumatic drill. (*Dorman Wave Power Tools*, published by W. H. Dorman & Co., Ltd., Stafford, England, 68 pp., illustrated, *d*)

MINING MACHINERY (See Machine Tools)

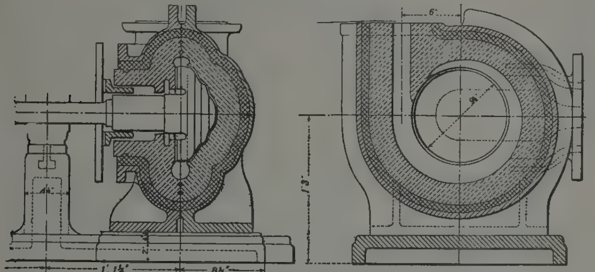
PUMPS

Pumps for Corrosive Liquids. The question of pumps for corrosive liquids is of particular, though not exclusive, interest to the chemical industry. Various materials have been tried which, while satisfactory for some purposes, failed under other conditions. Thus, ferrosilicon resists some acids but not hydrochloric acid, and is unsuitable for processes where contamination with iron must be avoided. Lead and regulus metal cannot be used for solutions containing metallic salts. Ebonite will not withstand hot liquids and is attacked by some chemicals.

It would appear that the substance which is most generally suitable for resisting the action of corrosive liquids is some kind of silicious ceramic material, as this can be obtained in forms entirely insoluble in almost any liquid. On the other hand, however, the usual type of ceramic material is difficult to shape and has somewhat unsatisfactory mechanical properties.

During the war, however, a new ware was developed under the necessity of finding some substance suitable for apparatus for condensation of large quantities of acid gas. Like silica ware, it can be plunged when red hot into cold water without cracking and has also good heat conductivity. This material was known as "ceratherm." Since the war a modified form of this material was adopted by Guthrie & Co. of Accrington, England, in the manufacture of their acid-proof pumps. This modified ceratherm material can be manufactured to accurate dimensions with greater ease than the original material.

The design of ceratherm pumps will be understood from Figs. 10 and 11. The acid-proof material forming the body of the pump is very thick and strong and is cemented into an iron casing. It is so arranged that it is only subjected by the bolts to crushing stress. The gland through which the plunger passes is usually on the section side, so that it is relieved from pressure, and the stuffing box is packed with a small quantity of wool, usually soaked in paraffin wax.



Figs. 10 and 11 Ceratherm Pump for Corrosive Liquids

The pumps are built mainly in small sizes to lift, say, from 20 to 100 gal. per min. against a head up to 120 lb., although pumps have been built for a head of 300 lb. and larger sizes have been made. (*Engineering*, vol. 110, no. 2851, Aug. 20, 1920, pp. 253–254, 6 figs.. *d*)

Roto-Piston Vacuum and Pressure Pumps. In these pumps the motions are produced by two cylinders, one, the Roto-piston, being enclosed in the other and touching it at only one point as they are mounted on different axes (Fig. 12). The inner is revolved at the same angular speed as the outer by cranks connecting the two cylinder heads. The throw of the cranks is such as to allow the Roto-piston pump to maintain contact with the outer case in an apparently eccentric motion which is, nevertheless, completely balanced. The crescent-shaped space between the cylinders is sealed at its ends by the contact of the cylinders and at any point by a vane which slides in the Roto piston and maintains contact with the outer cylinder.

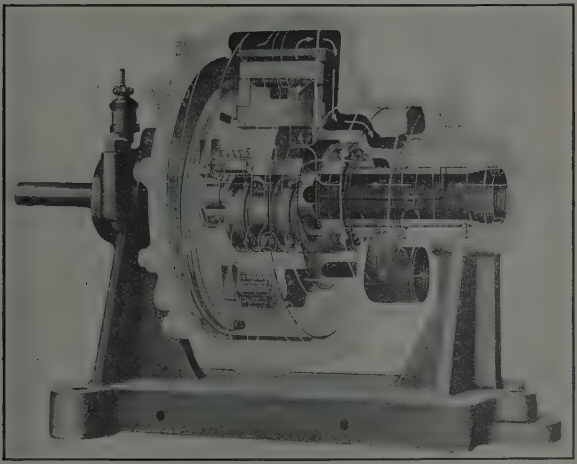


Fig. 12 Roto-Piston Pump

As the crescent chamber remains fixed in revolution the cylinders roll past it and the vane moves through with them, displacing the space as positively as in a reciprocating pump although the motion is rotary and continuous. It has a sliding area of a little over 1 in. on the outer case. The main shaft remains stationary during revolution. There are no valves and the pump is air cooled. The pumps are made in both pressure and vacuum types. (*Iron Age*, vol. 106, no. 7, Aug. 12, 1920, p. 393, 1 fig., *d*. The illustration used in Fig. 12 was obtained through the courtesy of the Crescent Sales and Engineering Co., Detroit, Mich.)

RAILROAD ENGINEERING (See Thermodynamics)

REFRIGERATION (See Thermodynamics)

SPECIAL MACHINERY (See Machine Tools)

British Machine for Testing Springs by Scragging

Spring-Scragging Machine. Description of a new type of spring-scragging machine recently designed by Samuel Denison and Son, Hunslet Foundry, Leeds, England.

The ordinary scragging test applied to springs consists, in the case of laminated springs, of flattening the camber, or, in the case of springs having no camber, of giving the spring a slight deflection. Helical or volute springs are tested by closing them down hard.

The system adopted in the new machine, Fig. 13, embodies a motor-driven variable-speed rotary oil pump on the Hele-Shaw principle. The scragging gear is virtually a vertical press with a horizontal table or anvil and a vertical inverted cylinder directly overhead.

The energy put into the spring on the down stroke serves to return the tup to its normal position without the use of the pump. Owing to the piston rod on the under surface of the piston, the effective cylinder volumes on the two sides differ. In order to get rid of the surplus oil on the upper side of the piston on the up stroke, therefore, it is bypassed back to the replenishing tank by means of a shuttle valve in the pipe service connecting the top of the cylinder and pump. This valve operates the bypass as soon as the pump is put in the neutral position. While the tup is moving up the underside of the piston is supplied with oil by suction, some of the oil from the top side of the piston being bypassed to the underside for this purpose.

It is possible with this arrangement to obtain about 40 complete strokes of the tup per minute. For this a large pump unit is necessary. In order to assist in rapidly controlling this a small relay pump is introduced into the system as shown in the illustrations. The latter pump is controlled by the operator by means of a lever, to be seen in Fig. 13, and hunting gear to the main pump control, the main pump cutting out the small pump as soon as its work is accomplished. The effort needed to set the small pump in operation is very small, as also is the hand movement necessary to secure the up and down strokes of the tup. (*Engineering*, vol. 110, no. 2851, Aug. 20, 1920, pp. 243–244, and an illustration on p. 242, *d*)

THERMODYNAMICS

Shape of Insulation and Efficiency of Heat Transfer

The Effect of Geometric Form upon the Heat Transfer through Insulation, C. E. Rose. The author investigates the methods for the selection of insulation for various uses: in particular, the relation between the shape of the insulating element to its efficiency as an insulator. This has a particular value for the refrigeration industry. In such applications as the insulation of steam piping, it is of course also desirable to make the insulating element as efficient as possible, but not so important as in refrigeration, because heat is much cheaper to produce than cold and therefore its loss is less important. The writer analyzes three cases, of which the first is quite common, while the other two, as he claims, have not been properly investigated.

The first case is that of cork board used for insulation with the

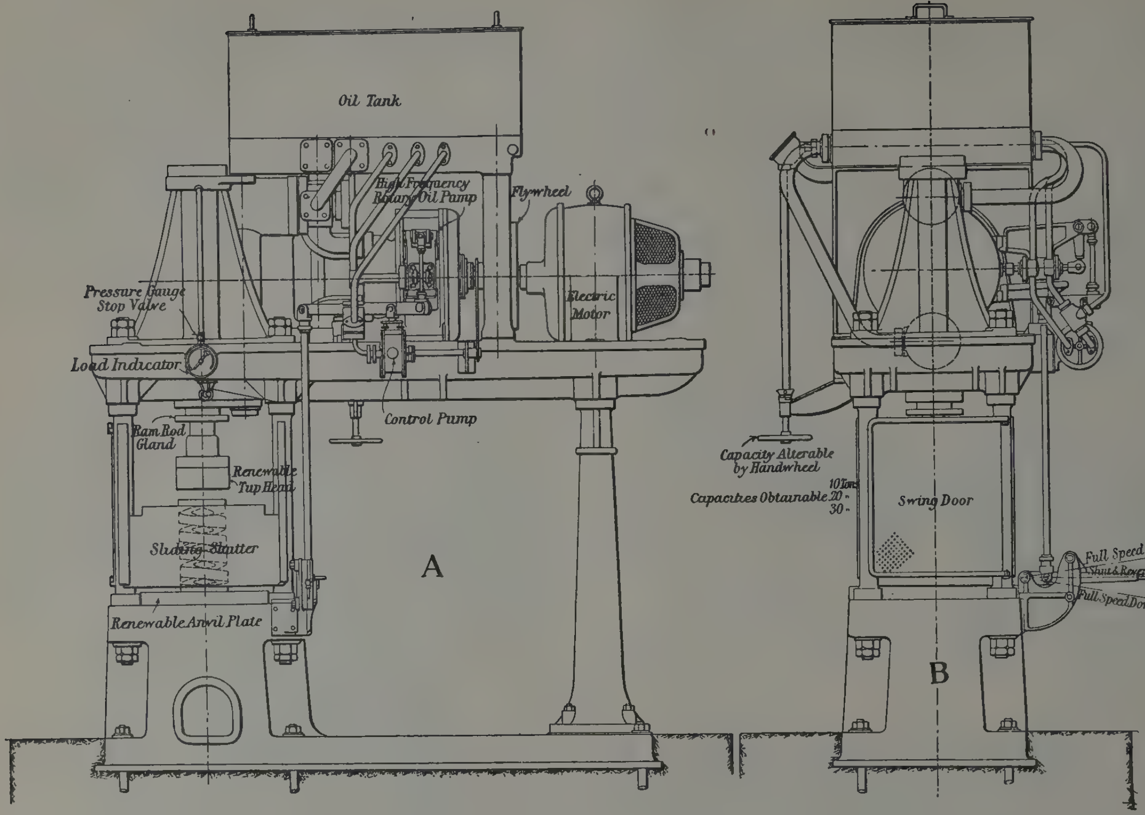


FIG. 13 NEW SPRING-SCRAGGING MACHINE OPERATING AS A PRESS

heat transfer occurring normally to its largest area. The second case is that of circular pipe insulated with a cylinder of insulation (Fig. 14). For this case the writer derives an expression

$$Q = C\,\frac{(1/R_1)(T_2 - T_1)}{\log_e R_2 - \log_e R_1} = \frac{C(T_2 - T_1)}{R_1 \log_e (R_2/R_1)} \ldots\ldots\ldots [3]$$

where Q is lb-deg. fahr. units transferred per sq. ft. of pipe surface per hour; C is a laboratory constant of heat transfer which has to be determined for each material; R_1 is the radius of pipe in inches; R_2 outside radius of insulation; T_1 temperature in deg. fahr., low side of insulation; T_2 temperature in deg. fahr., high side of insulation.

The expression

$$Q_1 = \frac{2\pi C(T_2 - T_1)}{\log_e (R_2/R_1)} \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

gives the rate of absorption for cold piping or radiation for hot piping.

If the rate of heat transfer is known and the thickness of insulation $R_1 - R_2$ must be calculated, the formula

$$R_2 = R_1 e^{\frac{C(T_2 - T_1)}{R_1 Q}} \ldots\ldots\ldots\ldots\ldots\ldots [5]$$

may be used, where e is the Naperian base.

Case 3 is that of a circular pipe enclosed in a square of insulation (Fig. 15), such as a pipe laid in a box or trench filled with granulated cork, the pipe being installed coaxially with the trench.

For this the author derives the following formulæ for the heat transfer:

$$Q_2 = C\,\frac{4}{\pi}\,\frac{R_2}{R_a}\left[\frac{(T_2 - T_1)}{R_1 \log_e (R_a/R_1)}\right] \ldots\ldots\ldots\ldots [7]$$

lb-deg. fahr. units per sq. ft. of pipe surface per hour, and

$$Q_2 = 8C\,\frac{R_2}{R_a}\left[\frac{(T_2 - T_1)}{\log_e (R_a/R_1)}\right] \ldots\ldots\ldots\ldots\ldots [8]$$

lb-deg. fahr. units per linear foot of pipe per hour, where R_2 is the mean integrated radius vector.

The writer takes numerical examples, one for each case, and ascertains what results the changes of form have upon the rate of heat transfer in unit time at constant thickness through 2 in. of formed cork having a heat-transfer constant $C = 0.49$ lb-deg. fahr. units per sq. ft. per deg. difference per in. of thickness per hour and a temperature difference of 100 deg. fahr. $= T_2 - T_1$.

The actual calculations are given in the article. In case 2, a 2-in. molded cork insulation is applied to a 2-in. pipe, in which case Equation [3] gives $Q = 37.8$ lb.-deg. fahr. units per sq. ft. per hr.

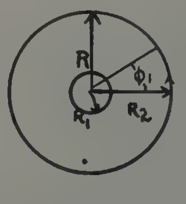


FIG. 14 CIRCULAR PIPE INSULATED WITH A CYLINDER OF INSULATION (DIAGRAMMATIC)

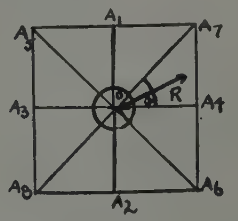


FIG. 15 CIRCULAR PIPE ENCLOSED IN A SQUARE OF INSULATION SUCH AS BOX OR TRENCH (DIAGRAMMATIC)

A similar computation for the case of cork-board insulation and heat transfer normal to its largest area gives for Q a value of 24.5 lb.-deg. fahr. units per sq. ft. per hr., whereas in case 3, with $R_1 = 1$ in. and a thickness of covering at A_4 of 2 in., gives 27.6 lb-deg. fahr. units per average sq. ft. per hr.

It would appear, therefore, that the second form transmits 54 per cent and the third form 11 per cent more heat (at the particular thickness of 2 in. with 2-in. pipes) than the first form. (*Ice and Refrigeration*, vol. 59, no. 3, September 1920, pp 82–84, 4 figs., *tp*)

Wire-Drawing Compression Method of Heating Gases —Causes of Overheating in Air Compressors with Leaky Delivery Valves

A Dynamical Method for Raising Gases to a High Temperature, Prof. W. H. Watkinson. If air be allowed to flow from the atmosphere through a spring-loaded wire-drawing valve adjusted so that the air in the cylinder during the charging stroke is constantly at a pressure of one-quarter of an atmosphere and if this air is subsequently compressed to atmospheric pressure, then, assuming adiabatic and frictionless conditions and neglecting the effect of clearance in the pump cylinder, the absolute temperature of this air at the end of compression will be approximately $1^1/_2$ times the absolute temperature of the outside atmosphere; that is, T_c, Fig. 16, will be approximately equal to $1^1/_2$ times 288, that is, 432 deg., when the atmospheric temperature is 15 deg. cent. The reason for this is that the constant-pressure line *a b*, Fig. 16, is approximately an isothermal line for the varying mass of air in the pump cylinder, and the temperature of the air during the charging stroke is approximately the same as that of the outside atmosphere.

From the equations giving the connection between temperature, pressure and volume of a given mass of gases undergoing expansion and compression, namely,

$$\frac{T_c}{T_b} = \left(\frac{p_c}{p_b}\right)^{\frac{n-1}{n}} = \left(\frac{V_b}{V_c}\right)^{n-1}$$

it is obvious that the absolute-temperature ratio depends on the absolute-pressure ratio and not on the magnitudes of these pressures. If in the above illustration the air had flowed into the cylinder at a pressure of 25 atmos. from a receiver in which the air was at a pressure of 100 atmos. and at a temperature of 15 deg. cent., the temperature of the air after compression in the pump to 100 atmos. would have been 432 deg. abs., i.e., the same as in the above case. Therefore, if a pump arranged as shown in Fig. 17 is used and air from the atmosphere is admitted to the pump cylinder *b* by means of the wire-drawing valve *d*, and this air after compression is discharged through the valve *e* into a receiver *f*, its temperature within this receiver will be 432 deg. abs. If this air is then admitted to the other end of the cylinder and is wire-drawn during admission, by the valve *g*, to one-quarter of an atmosphere, and then compressed to atmospheric pressure and discharged through the valve *h*, the temperature of the air in the pipe *i* will be 288 × 1.5^2 = 648 deg. abs. and its pressure there will be atmospheric.

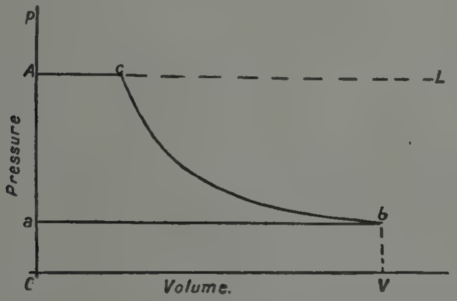


Fig. 16 Pressure-Volume Diagram for Compression with Wire-Drawing Valve

With five such double-acting pumps in series, the temperature of the air leaving the last pump at atmospheric pressure would be 16,600 deg. abs., providing the process could be carried out under the conditions assumed for the first stage. Actually, the temperature of the air leaving the second pump would be approximately 4600 deg. abs., and with our present materials and present types of compressors this is probably the upper limit at which the pump could be made to operate. Furthermore, to obtain the enormous increase of temperature stated above by single-stage compression would require the pressure ratio to be about 1,040,000, so that if the initial pressure was at one atmosphere the final would have to be 1,040,000 atmos. The multi-stage wire-drawing method described above might be regarded as a thermodynamic ratchet. One possible application of this principle may be indicated. If the pump shown in Fig. 17 be connected to the compression space of the cylinder *a* of an internal-combustion engine, the temperature of the air in the pipe *i* may be raised sufficiently high to effect ignition of fuel or of fuel and air in this pipe. If, for example, the air admitted to the pump cylinder by the valve *d* is wire-drawn to a pressure of one-half an atmosphere and then compressed to a pressure of two atmospheres and discharged through the valve *e* into *f*, where the pressure is one atmosphere, and if the process is repeated on the other side of the piston and the air discharged into the pipe *i* at a pressure of one atmosphere at the beginning of the compression stroke of the piston of the engine, then the temperature of the air in the pipe *i* will be the same as if this air had been compressed from one atmosphere to 16 atmos.; and if the compression pressure ratio in the engine cylinder is 10, the air in the pipe or pocket *i* will at the end of the compression stroke of the engine be at the same temperature as if it had been compressed from one atmosphere to 160 atmos., although its pressure will only be equal to 10 atmos., or that in the engine cylinder with which it is in free communication.

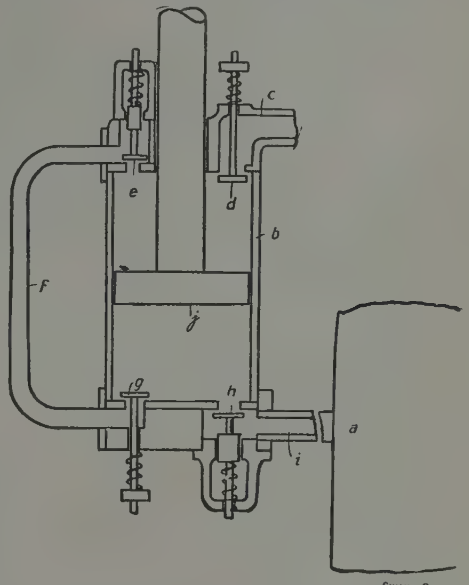


Fig. 17 Pump Arranged to Raise Gas Temperature Dynamically (Watkinson Method)

The above discussion would also explain why serious overheating may occur in air compressors having a leaky delivery valve. If, for example, in a single-stage air compressor compressing air to 4 atmos. the delivery valve was held partly open by any means during the charging stroke of the pump, and if it be assumed, as an extreme case, that the backward flow into the cylinder was at such a rate as just to maintain the pressure at one atmosphere during the charging stroke, then after 10 revolutions the air would, under adiabatic conditions, be raised to a temperature of 16,600 deg. cent. abs., and to a very high temperature under actual conditions. The temperature attained owing to such leakage might, in certain cases, be sufficient to cause melting of the valve. In the case of turbo-compressors, backward leakage due to a bent or fractured blade might raise the temperature sufficiently to cause melting of the blades. (Paper before the British Association, Section G, August 1920, abstracted through *The Engineer*, vol. 130, no. 3374, August 27, 1920, p. 198, 2 figs., *tpA*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

National Physical Laboratory of Great Britain

The Report of the National Physical Laboratory for the year 1919 has been issued. The report includes the report of the executive committee, a statement of the work proposed for the next year, a list of the papers published by the Laboratory or communications by members of the staff to scientific societies or journals, the report of the director, report of special work done in gage testing and other researches during the war. The heads of the various departments give accounts of the recent work in the laboratory. The subjects covered are as follows:

- Physics Department:
  - I—Heat:
    - *a* High-Temperature and General Work
    - *b* Thermometer Testing
    - *c* Oil-Apparatus Testing
  - II—Optics
  - III—Radium and X-Ray Work
  - IV—Tide Prediction
  - V—Library
- Electricity Department
- Metrology Department
- Engineering Department
- Aerodynamics Department
- Metallurgy Department
- The William Froude National Tank

Copies of the Report at 5s may be obtained from the Imperial House, Kingsway, W.C. 2, London.

Petroleum Research

The Petroleum Section of the American Institute of Mining and Metallurgical Engineers held meetings in St. Louis on September 21 and 22. An invitation was extended to the Petroleum Division of the American Society for Testing Materials and the American Association of Petroleum Geologists. The subjects of the papers dealing with research matters were as follows: Urgency for Deeper Drilling on the Gulf Coast, A. F. Lucas; Oil-Field Brines, Chester W. Washburne; Efficiency of the Use of Oil as Fuel, W. N. Best; Determination of Pore Space of Oil and Gas Sands, A. F. Melcher; Outline for Analysis of Oil-Field Water Problems, A. W. Ambrose; The Nature of Coal, J. E. Hackford; Extended Life of Wells Due to Rise in the Price of Oil, W. W. Cutler, Jr.; Oil Shales and Petroleum Prospects in Brazil, H. E. Williams.

Research Associations in Great Britain

In addition to those listed in the March and August issues of MECHANICAL ENGINEERING (pp. 181 and 470), the following Research Associations have received licenses from the Board of Trade under Section 20 of the Companies' Act of 1908:

The British Refractories Research Association, 14 Great George St., S. W. 1; Secretary, R. C. Rann.
The Scottish Shale Oil Scientific and Industrial Research Association, 135 Buchanan St., Glasgow; Secretary, W. Fraser, C.B.E.

The following Research Associations have been approved, but not licensed, in addition to those mentioned previously:

The British Electrical and Allied Industrial Association
The British Silk Association
The British Motorcycle and Cycle Car Research Association
The British Cutlery Association.

The following Associations are preparing Memoranda and Articles of Association in addition to those previously listed:

Jute Spinners and Manufacturers
Gray and Malleable Cast-Iron Founders.

Research Résumé of the Month

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Air A2-20 Blasting Granite with Compressed Air. Report on investigation Serial No. 2154 by Oliver Bowles deals with the use of compressed air in the final blasting of granite. In granite quarries where no joints or "sheeting planes" occur, two holes 3 in. in diameter are drilled close together to a depth of about eight feet. A small charge of about a spoonful of black blasting powder is placed in each hole, tamped with clay and fired. This starts a small fracture leading out horizontally from the two holes and by successively larger charges the fracture is enlarged in area until compressed air at 100 lb. can be put in the holes through pipes which have connections made airtight by means of sulphur. This air supplied over an enormous surface exerts an upward pressure and continues the enlargement of the fracture. Address Bureau of Mines, Washington, D. C., F. G. Cottrell, Director.

Apparatus and Instruments A12-20 Method for Measuring Interior Diameter of Ring Gages. A method employing two steel balls, the sum of the diameter of which is slightly larger than the nominal inside diameter of a ring to be measured, has been devised by the Bureau of Standards. The ring is laid on a surface plate and the larger ball placed in the ring and the smaller ball then rests against the inside of the ring, and on the larger ball. The difference in vertical position between the upper surfaces of the two balls is determined by a micrometer. This distance is easily converted into the vertical distance between the centers of the two balls. From this the horizontal distance between the two centers is determined from the right-angled triangle formed by the vertical distance, horizontal distance and distance between centers of the balls. From the above the diameter of the ring is determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A13-20 Quantitative Measurement of Consistency. The Bureau of Standards has developed a method for the quantitative measurement of consistency. This consists in forcing the material under investigation through a capillary tube by means of air pressure. Runs are made at various constant air pressures. Values which are deduced from the readings determine consistency. This does not determine the plasticity, and the Bureau is at work on a plastometer, Scientific Paper No. 276 and Technologic Paper 169, as well as papers in the Proceedings of the A. S. T. M. for 1919–1920, show the application of this apparatus. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A14-20 Etched Balls for Brinell Tests. When specimens are tested in polished state the impressions from etched balls are very distinct, while those from unetched balls are almost invisible from certain angles. The steel ball is etched for about one minute before the test in a 2 per cent alcoholic nitric acid solution. If the specimens are not polished, preliminary etching of balls does not seem to be of much advantage. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A11-20 Penetration of Water. The Bureau of Standards has devised a new apparatus to determine the rate of penetration of water through building materials. No special form of test piece is necessary if one face of the specimen is fairly smooth. A complete test of materials has not been made but from the preliminary investigation the table below has been prepared:

Test Specimen	Absorption in 24 Hours, Per cent	Thickness, In.	Water Pressure, Lb.	Time Required for Penetration through Wall
Limestone 50..........	5.80	$1\frac{5}{8}$	60	$10\frac{1}{2}$ min.
Limestone 7E.........	3.10	$1\frac{5}{16}$	60	11 min.
Limestone 8907.......	4.40	$1\frac{5}{8}$	60	19 min.
Limestone 9c	4.60	$1\frac{5}{8}$	60	$2\frac{2}{3}$ min.
Limestone No. 5G....	3.48	$1\frac{1}{4}$		$1\frac{1}{2}$ min.
Sandstone............	5.56	$2\frac{1}{2}$	60	10 sec.
1 : 6 Portland-cement mortar............	7.8	2	60	$3\frac{1}{2}$ hr.
1 : $1\frac{1}{2}$: 2 concrete....	5.8	2	60	(*a*)

(*a*) Did not fail in 24 hr.; when broken through water had penetrated but $\frac{1}{2}$ in.

Fuels, Gas, Tar and Coke A11-20 Gasoline from Natural Gas. Factors in Determining the Gasoline Content in Natural Gas by the Absorption Method is the title of a Report Serial No. 2157 to the Bureau of Mines by D. B. Dow. This report deals with certain factors which should be considered in making absorption tests to determine the gasoline content of natural gas using "mineral seal oil" as the absorbent. The method is described in Technical Paper 232, Bureau of Mines 1919, by Dykema and Neal. The factors to be considered are the saturation in the absorbent oil which should be as high as possible in the first compartment and low in the third and fourth compartment, the loss in distillation, the rate of distillation, the temperature of the condenser and the stopping of the distillation by means of the mineral seal ring rather than by temperature readings. The rise in temperature to 350 deg. fahr. should take between 12 and 30 min. The condenser should be held at 60 deg. fahr. Bureau of Mines, Washington, D. C. Address M. G. Cottrell, Director.

Fuels, Gas, Tar and Coke A12-20 The Coal Fire. The Department Scientific and Industrial Research through its Fuel Research Board has made a special Report No. 3 on the Coal Fire. This includes the work of Dr. Margaret Fishenden on Domestic Heating, the investigation of the efficiency of open fires and on air pollution from domestic heating. Copies at 4/3 may be obtained from the Imperial House, Kingsway, London, W. C. 2.

Fuels, Gas, Tar and Coke A13-20 Colorado Oil Shale. Martin J. Gavin, Bureau of Mines and Leslie H. Sharp, State of Colorado, have made report No. 2152 to the Bureau of Mines on some physical and chemical data of Colorado oil shale. The experiments were made on samples which represented an average of the massive type of oil shale encountered in Colorado. The results show a yield of 42.7 gal. of oil of 0.905 specific gravity from 2000 lb. of shale. The specific gravity 0.905 or 24.7 deg. B was determined at 15.56 deg. cent. or 60 deg. fahr. The weight of the shale per cu. ft. is given below:

Size	Run of mine	—1 in.	—$^1/_2$ in.	—$^1/_4$ in.
Weight, lb. per cu. ft.	53.775	54.775	56.015	58.200

The apparent specific gravity varied from 1.92 to 2.06. The specific heat from 20 to 90 deg. cent. varied from 0.223 for spent shale to 0.265 for raw shale. The heat of combustion of raw shale was 2460 calories per gram or 4428 B.t.u. per lb. In making this determination it was found very difficult to get complete combustion, even when using oxygen at 500 lb. pressure. The ash residue in most cases contains considerable combustible matter. The thermal conductivity for ranges of 25 to 75 deg. cent. was 0.0032 in absolute units, for which the conductivity of copper is about 0.91. The proximate analysis shows moisture 0.60 per cent, loss on ignition 40.00 per cent, and ash or residue 59.40 per cent. The analysis of the ash gives about 45 per cent silica, 26 per cent iron and alumina, 18 per cent lime, 5.3 per cent magnesium. The heat of combustion of crude shale oil is 10,215 calories per gram or 18,387 B.t.u. per lb. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Glass and Ceramics A2-20 Telescope Objectives. A paper has been prepared by the Ordnance Department which deals with the possible sets of simultaneous values of spherical and chromatic aberration which may be obtained from a two-piece cemented telescope objective of barium crown glass and flint glass. Sets of contours are presented which show in a complete form the manner in which the different aberrations change as the radii are altered. See *Journal of the American Optical Society.* Also S. Tour, Metallurgical Section, Ordnance Dept., Washington, D. C.

Industrial Management A1-20 Code for Head and Eye Protection. The National Safety Code for the protection of head and eyes of industrial workers has just been sent to the press. For two years the rules have been published in mimeographed copies for criticism and correction. The Code specifies appropriate protectors against mechanical hazards such as flying particles, dust, chemical fumes and excessive light. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Iron and Steel A2-20 Boiler Plate at Elevated Temperatures. The tensile properties of boiler plate at temperatures up to and including 563 deg. fahr. are not affected by the rate of loading from very slow loading up to 1.6 in. per min. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mining, General A4-20 Stench Warning in Metal Mines. A. C. Fieldner and S. H. Katz have made a report on this subject in Serial 2153 to the Bureau of Mines. In order to send warnings, messengers, electric lights, telephones, the interruption of the flow of compressed air or the introduction of water into the compressed-air lines have been used. Experiments have just been made on the introduction of a material which would cause a strong odor or stench that could not be mistaken. The liquids suggested have been ethyl mercaptan (C_2H_5SH) and amyl acetate. Ethyl mercaptan boils at 98 deg. fahr. and freezes at 228 deg. below zero. It has a disagreeable and characteristic skunk-like odor which will not be mistaken for odors commonly found in mines. It can be obtained from certain chemical manufacturers at $2.25 per lb. Amyl acetate may be obtained from any chemical-supply house or from dealers in paints and lacquers. This has a banana-like odor which is not objectionable but distinctive. Tests have been made in a large number of mines proving the effectiveness of ethyl mercaptan. The amyl acetate tests were not so effective in a short time. $1^3/_4$ pints of ethyl mercaptan or $3^1/_2$ pints of amyl acetate are required for each 100,000 cu. ft. of free air entering the mine per minute. The injector is constructed of a stout glass cylinder or airtight metal cylinder capable of withstanding the pressure in the line. It is connected above and below the liquid to the air line with short $^1/_2$-in. pipes. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Paints, Varnishes and Resins A1-20 Talc in Fire-Resistant Paint. A fire-resistant paint has been prepared by the Paint Manufacturers' Association started through Henry A. Gardner at the Institute of Industrial Research, Washington, D. C., and Dr. Herman Von Schrenk, of St. Louis. The formula for the paint is as follows: 10.6 lb. basic sulphate white lead, 11 lb. zinc oxide, 33 lb. asbestine (magnesium silicate or talc), 0.5 lb. borax, 0.9 lb. dry lampblack, 24 lb. linseed oil, 2 lb. liquid drier and 10 lb. mineral spirits. It is noted that 33 per cent of the paint is talc. Although called asbestine, this is not a form of asbestos. The material is being tested at present by the Underwriters Laboratory. See Report of the Bureau of Mines, Serial No. 2150. Address Bureau of Mines, Washington, D. C., F. G. Cottrell, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Chemistry, Inorganic, B2-20 Ferric Oxide with Small Percentage of Fused Salts. An investigation is being made of the physical and chemical properties of ferric oxide fused with small quantities of various salts. Waltham Watch Co., F. P. Flagg, Chief Chemist, Waltham, Mass.

Glass and Ceramics B3-20 Enamel for Watch Dials. The Waltham Watch Co. is investigating a satisfactory method of determining the properties of the enamel used on watch dials. Difficulties have been encountered in finding satisfactory methods for determining constituents. Physical properties are being studied. These include the coefficient of expansion, viscosity, melting point, opacity and color. Address Waltham Watch Company, F. P. Flagg, Chief Chemist, Waltham, Mass.

Lubricants B1-20 Lubrication at High Temperatures. Tests of viscosities at high temperatures of asphalt and paraffin base oils at 300 deg. fahr. and lower. Address Lockhart Laboratories, L. B. Lockhart, Atlanta, Ga.

Metallurgy and Metallography B12-20 Furnace Linings and Brass Alloys. The effect of different brass-foundry alloys on different refractory materials used for furnace linings in crucible furnaces, open-flame oil furnaces and electrical furnaces. The Lumen Bearing Company, Address C. H. Bierbaum, Buffalo, N. Y.

Metallurgy and Metallography B13-20 Bearing Alloys. A study of the methods of eliminating impurities incident to improper foundry methods for bearing alloys. Address Lumen Bearing Company, C. H. Bierbaum, Buffalo, N. Y.

Metallurgy and Metallography B14-20 Bearing Alloys. The possibility of using new alloys for bearing purposes and limitations of different alloys now in use. Lumen Bearing Company, Address C. H. Bierbaum, Buffalo, N. Y.

Textile Manufacture and Clothing B3-20 Work of the United States Testing Company. The work in progress at the United States Testing Company is devoted to various phases of textile work.

1 Standardization of Fading Tests. Design and construction of special holder for several samples exposed to artificial light. Comparison of results at Rutgers College, University of Nevada, and in New York City.
2 Mechanical tests as a means of classifying raw silks.
3 The effects on the color in finished knit goods of different ways of doubling and twisting in hosiery tram.
4 Some apparent anomalies in the colorimetric estimation of dyestuffs.
5 Lousiness.
6 A comparison of artificial silks among each other and natural silks.
7 Standardization of chemical methods of determining the per cent content of silk, wool and cotton in fabrics.
8 Weighting and durability of silk fabrics.
9 Relation of laundering processes to fastness of colors.
10 Identification of dyestuffs and intermediaries.
11 Soaps and oils for textile work.
12 Photomicrography of fabrics.
13 Determination of the soap and oil content of thrown silk by extraction method.
14 Chemical and physical characteristics of the sericin and fibroin in so-called hard and soft silks.

Address R. E. Douty, General Manager, U. S. Testing Company, 340 Hudson St., New York.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Machine Design C2-20 Ball Bearings at High Speeds. The performance of ball bearings at from 7,000 to 25,000 r.p.m. is being investigated theoretically by Panfilo Trombetta. Investigation of a theoretical and experimental nature is desired. Address Panfilo Trombetta, General Electric Company, Schenectady, N. Y.

Metallurgy and Metallography C2-20 Cartridge Brass. Relation between hardness, tensile strength and amount of cold work on cartridge brass containing 68 to 71 per cent copper, 32 to 29 per cent zinc, and not less than 0.07 per cent lead and not less than 0.05 per cent iron. In the annealed condition the relation between hardness and grain size is known. The relation between the amount of cold work, hardness and tensile strength for metals of different grain size is desired. Address S. Tour, Metallurgical Section, Office of the Chief of Ordnance, Washington, D. C.

Metallurgy and Metallography C3-20 Overstrain in Steel. The effects of overstrain on steel and the influence of time and temperature on these effects. The statement that elastic limit of steel may be increased by cold work or by the application of excessive stresses is often made. It is desired to know the physical characteristics of steel subjected to cold work or to excessive stresses above the elastic limit and the effect which time and temperatures less than 600 deg. cent. have upon these characteristics. Address S. Tour, Metallurgical Section, Office of the Chief of Ordnance, Washington, D. C.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Simonds Steel Mills D1-20 Simonds Manufacturing Company has just completed an addition to its research laboratory at its steel mills in Lockport, N. Y. The building is 40 by 50 ft. New equipment consisting of a special-type electric melting furnace of 300 to 500 lb. capacity and electric heating furnaces with other equipment for extending facilities for research and development work has been added. New formulæ and methods for making special steels are being worked out under the direction of an expert metallurgical staff.

Doehler Die-Casting Company D1-20 Laboratories equipped for making chemical and physical tests of materials, particularly those used in non-ferrous alloys and especially alloys used in die casting. Doehler Die-Casting Company, Address Charles Pack, Chief Chemist, Court, Ninth and Huntington Sts., Brooklyn, N. Y.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Can Engineering Students be Given Broad Conception of Production and Management?

To the Editor:

Mr. Benedict describes in his paper in the September number what he modestly offers as a partial contribution toward the improvement of engineering schooling. His work exemplifies current systems of shop operation and management. This covers a considerable part of the field of industrial engineering, but not the whole field. Engineers, and particularly mechanical engineers, are too apt to think of machine-shop operation as typical, if not inclusive, of production generally. A result is that in those industries which are quite dissimilar from the shop, engineers class themselves as mechanical men rather than as production men.

If applications of engineering are to be taught in the schools, other industries as well as the shop should have attention. A very few may be mentioned: steel manufacture; the refining of petroleum products; sugar processing; the manufacture of pulp and paper. Shop methods cannot be applied, unmodified, in the production departments of these industries.

Few schools if any can have model paper mills or sugar refineries. They can teach, do teach and should continue to teach, the scientific principles underlying these and all industries. They must now also attempt to develop and teach operation and management principles. There must consequently be some study of operation. This cannot in general be carried on in the experimental way which Mr. Benedict develops for the shop. It must be done by industrial research or survey conducted by means of seminar or thesis assignments, including visits to manufacturing plants. These visits should be of a month or two in duration, not of an hour or two. They will make graduates more immediately useful in the special industries examined; but this is not the main point, or the chief function of the school, which should be concerned with the producing power of its graduate over his whole economic life. The real advantage of the study of typical industries is in its broadening and stimulating effect, and in its confirmation or illustration of fundamental principles.

To carry out such a program requires a rather unusual amount of coöperation from the manufacturers, and the manufacturers must not expect too much immediate or direct benefit. Education is about the longest-range operation we have today.

The new professional course in industrial engineering, which has just been announced by Columbia University, has been prepared with some of these points in mind. Studies are grouped under General Engineering, Business, Machinery, and Industrial. In the last group provision is made for four months, work in a factory, half the time as a student-worker and the balance in directed study and analysis. The major courses in this group are those dealing with manufacturing processes and it is interesting to note that the non-metallic industries are assigned fully half the total time. Processes and mechanical operations are analyzed and the characteristics of machines examined. In the third year of this graduate course each student selects and studies, under guidance, some particular industry. This need not be (although it often will be) a metal-working industry. The study will include a survey of commercial, financial and technical factors, with contemplation of ways and means for improvement. As a test of accomplishment, a final course aims to develop methods of analysis by which the machinery and equipment may be selected for manufacturing an assigned commodity according to an assumed schedule. A part of the job is the preparation of a financial budget for the operation.

The obvious reflection in connection with a program as ambitious as this is that it requires teaching of unusual type and scope. But with the right sort of handling the value of work of this kind should be very great.

132 Naussau St.
New York, N. Y.

William D. Ennis.

The New Ford Plant at River Rouge, Mich.

Notes of Interest Regarding the Features of This Unique Plant, Gathered Through the Visit of the Cleveland Engineers

MENTION was made in the last number of the recent excursion of the Cleveland engineers to Detroit, and of the visit to the new Ford plant at River Rouge. In *Cleveland Engineering* for September 7, the journal of the Cleveland Engineering Society, is an account of the trip, from which the following notes are taken:

About the Ford Plant

Heretofore, iron ore—the rock itself as it is taken from the mine—has never been listed as an automotive part. Even the most completely equipped, self-contained automotive factory, a plant fabricating steel and manufacturing a majority of the units going into its product, has never gone back farther than iron pigs and raw steel.

At River Rouge, one of Detroit's western suburbs, this dream of Henry Ford's is approaching realization. The Clevelanders found River Rouge the scene of an industrial development program of such proportions that its scope is almost incomprehensible.

Points of interest were the waterway, storage yards, by-product plant, blast furnaces, a large body plant which formerly was the Eagle boat plant, power house and foundry, the latter three in course of construction.

The waterway consists of a turning basin large enough for the longest lake vessel, and a slip half a mile long, 250 ft. wide and 25 ft. deep. The Government recently has begun contract work on the widening and deepening of the River Rouge for a distance of two and a half miles from the plant to the Detroit River, which will put the plant on the 22-ft. waterway of the lakes. The visitors had an opportunity to see the hydraulic dredges at work.

The storage yards for coal, stone and ore, just completed, were inspected. The boat-unloading equipment was not operating, pending completion of the Government channel. Meanwhile the company gets its ore by rail.

The by-product plant was in full operation, turning out coke, illuminating gas, light oil, tar and ammonium sulphate.

The plant in general occupies about 23 acres. When Mr. Ford's entire project is realized it will take in a site of nearly a thousand acres. The 120 coke ovens produce 1700 tons of coke, 18,000,000 cu. ft. of gas, 10,000,000 of which is being sold to the city of Detroit, 4000 gal. of benzol, 16,000 gal. of tar and 27 tons of ammonium sulphate, sold as a fertilizer.

Each of the four blast furnaces will have a capacity of 500 tons of iron daily. Every casting and steel part used in the Ford automobile, truck and Fordson tractor will be manufactured at River Rouge when the plant enters into full production.

The power house will consume 1000 tons of coal daily. When complete it will contain turbo-generators of 65,000 kw. capacity and five turbo-blowers of 40,000 ft. capacity a minute. Five 2000-ft.-a-minute air compressors will supply air to the plant for manufacturing purposes. Eight 2640-hp. boilers will be fired by blast-furnace gas and pulverized coal.

The plant is unique in three respects. It will be the first complete consolidated blast furnace, foundry and steel mill in the world. It will be the first large power plant in this country to utilize pulverized coal. It will be the first to make castings from metal coming directly and uncooled from the blast furnaces. This is a feat which engineers have said could not be done.

In engineering circles, the announcement that the Ford company planned to pour hot metal directly from the furnaces to molds, eliminating the remelting of pig iron in the foundry cupolas, has been received with unusual interest.

It was this feature that the Cleveland visitors were particularly anxious to see. However, pending completion of the foundry, the metal is being made into pig and the engineers had to be satisfied with an explanation of the process. In working this process out the cupolas have not been eliminated entirely, but the metal from the furnaces and the metal from the cupolas will be mixed in definite proportions.

At the time of the excursion pamphlets were distributed by the George T. Ladd Co., Pittsburgh, Pa., on the boilers which they are building for this plant, probably the largest boilers ever constructed, with brief reference, also, to the superheaters and method of firing. The pamphlet states:

Boilers of the Power Plant

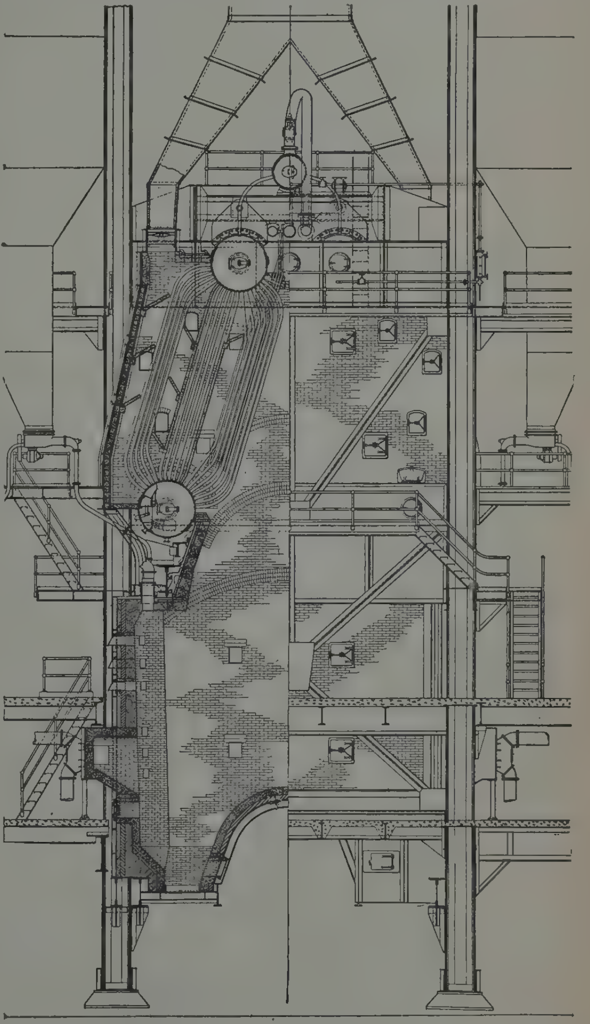
These boilers each contain 26,470 sq. ft. of heating surface, which is exclusive of superheater heating surface, or surface of future economizer. Inasmuch as this heating surface is substantially all in the tubes, it required for each boiler nearly six miles of $3^{1}/_{4}$-in. tubing. Steam will be generated at 240 lb. per sq. in. and superheated 200 deg. fahr.

The main steam and water drums are 5 ft. inside diameter by 25 ft. $10^{3}/_{4}$ in. long, with $^{15}/_{16}$-in. thick shell plates. The steam is led from the two main top drums to a 36-in. steam drum equipped with two 10-in. nozzles, which connect with the two saturated-steam headers of the superheater.

The furnace, while irregularly shaped, is approximately 23 ft. by 24 ft. inside by 55 ft. high above the ashpits. The combustion space allowed by this furnace, exclusive of ashpits, is about 5 cu. ft. per normal rated horsepower. The total height of the boiler from the ashpit floor to the top of the superheater piping is 82 ft. $9^{7}/_{8}$ in.

The settings of the boilers presented many difficulties owing to the extreme size of the furnaces. The lower main walls are $33^{3}/_{4}$ in. thick at the haunches with a 9-in. vertical invert at the center. All the high-temperature zones in the furnace are lined with $13^{1}/_{2}$ in. of firebrick. A sectional view and side elevation of one of the boilers and its setting are shown in the accompanying illustration.

Economizers are not to be installed at the start, but provision is made in the structure for their future addition. The superheater arrangement, however, permits a full 3-pass gas travel for each side of the boiler, which, coupled with the fact that the passes can be baffled as closely as is consistent with the ratings desired, seems to assure reasonably low stack temperatures. Mounted over each boiler and supported by the building framing will be a steel stack 11 ft. inside diameter, with the top reaching 327 ft. above the ash-floor level.



Sectional View of Boiler Unit, Ford Plant

Superheaters

Each superheater consists of three headers, two 10 in. in diameter and one 12 in., all approximately 23 ft. long, together with the connecting elements.

The headers are located below the boiler steam drum, with the larger in the center and the two smaller on each side. Steam is taken from two points on the boiler collecting drum and led to the ends of the 10-in. saturated-

(*Continued on page 654*)

MECHANICAL ENGINEERING

The Monthly Journal Published by The American Society of Mechanical Engineers

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Mechanical Engineering Changes Printers

For the past ten years, Mechanical Engineering has been printed at the plant of the Williams Printing Company, New York, one of the largest, best-equipped and best-organized printing establishments in the country. The service which this company has rendered has been of the highest order and the careful attention which its employees have given to the execution of the work upon Mechanical Engineering has been all that could be desired, and deserves the highest praise. The rapidly rising cost of production in the printing industry, however, has made it seem advisable to the Publication and Papers Committee of The American Society of Mechanical Engineers to have the printing done in a smaller city where the overhead charges and cost of living, and consequently cost of production, are lower than in New York. Accordingly, this journal is now to be printed by the Eschenbach Printing Company, Easton, Pa., which, under the postal laws, becomes the publication office. The editorial and business offices will remain at the headquarters of the Society, 29 West 39th Street, New York, and all communications should be sent to the New York address.

It probably is not realized by the average person that the increases in costs in the publishing business have been greater since the beginning of the war than in almost any other line of industry. We are accustomed to think of the prices of commodities as having advanced about 100 per cent during this period; but if the cost of publishing had advanced *only* 100 per cent, those who issue periodicals would now be supremely happy and would have no cause for concern. The following items give the percentages of increase which have occurred since 1914 in the production of journals like Mechanical Engineering and indicate how great has become the expense of issuing a periodical:

Per Cent Increase in Printing Costs Since 1914

Machine Composition	105
Hand Composition	218
Presswork	170
Binding	118
Paper	300
Engravings (inch rate)	110
Engravings (minimum sizes)	275

The greatest advances have occurred during the past two years, and to a large extent since the printers' strike in New York City last fall. Nevertheless, the Society has not only maintained Mechanical Engineering during this trying period on the same basis and with the same complete presentation of its matter as in previous years, but in addition has made notable improvements, one of which is the inclusion of The Engineering Index.

As for the new printers, the Eschenbach Printing Company has for many years handled the publications of the American Chemical Society and is well equipped for scientific work. Its facilities are to be enlarged to accommodate Mechanical Engineering, and while it has not been possible to secure the complete installation of machinery and materials in time for the present number, new presses and composing-room equipment will shortly be in place. For several years past this company has printed Condensed Catalogues, the superior appearance of which is evidence of the workmanlike manner in which its printing has been handled.

In one respect, at least, it is hoped to render better service in the new location than heretofore, namely, in the distribution of Mechanical Engineering through the mails. There have been frequent and annoying delays because of the congestion caused by the tremendous amount of printed matter which has to be handled by the New York Post Office, a condition which does not exist to a like extent in the smaller cities.

The Superpower Survey

William S. Murray

In 1905 Mr. W. S. Murray, chairman of the Superpower Survey, was called to the New York, New Haven and Hartford Railroad Company to supervise the electrification of its lines adjacent to New York. This brought forcibly to his attention the economic advantages resulting from the consolidation of power units for the electric distribution of power for industrial and railroad purposes. It is therefore greatly to his satisfaction that Congress has authorized an investigation of the possibilities of the superpower system for the eastern section of the country, which is creating so much interest among engineers and others connected with our industrial plants and transportation systems.

The proposed plan has for its central idea the construction of an electrical regional power system applicable to the industries and railroads existing within the territory between Boston and Washington and inland from the coast 150 miles. By the installation of high-powered, high-economy tidewater steam plants, hydroelectric stations, and steam stations located at the mouth of mines, all interconnected with a transmission system, and using also the large central stations now built and located at the larger cities, such as in Boston, Providence, New York, Philadelphia, and Baltimore, there can be integrated one great regional power system from which power can be delivered to the industries and railroads.

The area above-mentioned is the most congested industrial and railroad district in the United States. Here are located hundreds of steam-electric power plants, mostly of small capacity, using on a conservative estimate an average of 40 lb. of steam per kw-hr., as against the probable rate of 15 lb. when supplied from the superpower system. In Mr. Murray's opinion the machine capacity of this district is 17,000,000 hp., of which 10,000,000 is industrial and 7,000,000 railroad. The load factor is not over 15 per cent instead of 50 per cent or more which would result if power were concentrated on a single bus system and distributed therefrom to the industries and railroads.

By such concentration of power there would also result an enormous saving in maintenance through the substitution of electric for steam drive in the factories and on the railroads, and also by the reduction of train-miles on the railroads by virtue of the ability of the electric locomotive to consolidate a greater tonnage in single trains. Automatically, also, labor and maintenance costs at the mines would be greatly reduced and cargo space on the rails now required for useless coal haulage released for other commodities so urgently needed at the present time. Preliminary estimates indicate that the total annual saving from these various results would aggregate $300,000,000.

Facts such as these were brought out at meetings of the American Institute of Electrical Engineers and of other societies, and finally led the Engineering Council, the central body of the national engineering societies of America, to pass a resolution at a meeting held a year ago this month, advocating an appropriation by Congress for a survey of the superpower project. In April, 1920, a committee, of which Mr. Murray was chairman, was appointed by the Council to present the matter before the Appropriations Committee of the House of Representatives. The hearing was held March 18, and testimony was given by Prof. L. P. Breckenridge, Mem.Am.Soc.M.E.; Prof. D. C. Jackson, Mem.Am.Soc.M.E. and Past-President of the A.I.E.E., and Mr. Murray. The case was reported favorably to the House and ably presented there by Chairman Good of the Appropriations Committee; and $125,000 was appropriated for the power survey.

The work is now being prosecuted by an organization known as the Superpower Survey, under the jurisdiction of the U. S. Geological Survey, with headquarters at 709 Sixth Avenue, New York City. Mr. Murray has divided his engineering staff into three departments of investigation: (1) Power and Transmission; (2) Railways; and (3) Industries, with a division chief at the head of each and an engineer-secretary assigned to the duty of collaborating with these division chiefs in collecting and collating data.

The services of the chief hydraulic engineer of the Geological Survey and of the chief mechanical engineer of the Bureau of Mines are being contributed in part to the engineering staff of the Superpower Survey. Further assistance is being rendered by an Advisory Board of men representative of power producers and power consumers, and of the people as a whole representing a national power policy. Mr. Murray has selected and the Secretary of the Interior has appointed to membership on this Board, gentlemen who would be representative of New England railroads, New York railroads, engineering, technical publicity, the National Electric Light Association, the American Electric Railway Association, and the National Industrial Conference Board. Prof. L. P. Breckenridge, of Yale University, is chairman of this Advisory Board.

The superpower project, in Mr. Murray's opinion, which is in accord with others, marks the beginning of a national power policy and he believes its advantages as developed for the eastern district will be applicable to other districts in other parts of the country, and will constitute one of the most important movements ever developed for the conservation of our fuel and for the economical production of needed products. It will serve to speed up, increase and maintain production in this country at a high point of efficiency, and give to the public a service such as they have a right to demand. [Prepared from notes supplied to Mechanical Engineering by Mr. Murray.—Editor.]

Engineers in Public Service

It is gratifying to know that others besides engineers are coming to recognize that the type of mind and the training of the engineer tend to qualify him for responsible executive positions in the service of the public. We all know that, as city managers, members of public-service commissions, etc., they have been for some time rendering valuable and appreciated service.

It is safe to say that Herbert Hoover is perhaps the most widely known and most generally admired public man, the world over, now living.

A member of The American Society of Mechanical Engineers, Mr. Norman J. Gould, is a member of Congress, and James Hartness, Past-President, Am.Soc.M.E., has recently been nominated by the Republicans for Governor of Vermont—a nomination which is generally conceded to be equivalent to election.

Governor Cox has said that when elected he will try to induce Mr. Hoover to enter his Cabinet; and that Governor Cox believes in engineers for executive work was further shown by an incident related to me in a conversation I had with Mr. H. S. Riddle, Mem. Am.Soc.M.E., of Columbus, Ohio, on June 2, which, it will be noted, was some time before the nominating conventions. Mr. Riddle is President of the Ohio Board of Administration and as such he has general charge of all the institutions of the state except the penitentiary. In the course of a conversation about his work he told me, incidentally, how he came to undertake it.

Shortly after Governor Cox took office for his first term, now nearly six years ago, he asked Mr. Riddle to come to his office. On arrival, Mr. Cox said he had been looking for a man to administer the state institutions—had been informed that he, Mr. Riddle, was the man for that work and he asked him to accept the appointment. Mr. Riddle replied to the effect that he was not looking for a job and besides, said he: "Governor, I don't know as you and I would get along so very well, for you are a Democrat, while I am a Republican." Thereupon Mr. Riddle was assured that what was wanted was a man who could and would manage the state's institutions as they should be managed. Investigation had shown that Mr. Riddle was such a man and what his politics might be made no difference. Mr. Riddle thereupon recognized it as his duty to accept and he still holds the position, which I am sure he fills in a very able manner.

The incident shows that engineers, without regard to their politics, are being more and more sought by public officials for service in the conduct of public work, even when that work is not strictly of an engineering character; and that, I think, is cause for gratification. Fred J. Miller.

Saving the Natural Gas

The growing apprehension as to the possible (and probable) early exhaustion of the natural-gas supply has led to several important developments for its conservation and economy in its use.

The main influence in this direction has been the effective work of the National Committee on Natural Gas Conservation, appointed last January by former Secretary Lane, which has worked in coöperation with the U. S. Geological Survey of the Department of the Interior. On June 11 this committee made a final report at a conference of Governors and members of public-utility commissions of the natural-gas-producing states, held at Washington, D. C., in which were incorporated rules and regulations for gas production, transmission and utilization.

The spirit of these recommendations has been admirably expressed in an administrative order issued last August by the Public Utilities Commission of Ohio. This order designates two classes of consumers of natural gas: domestic consumers and industrial consumers, and so classifies these as to indicate in what order service is to be discontinued during an emergency in order to conserve a supply of gas for domestic consumers, and in what order service is to be restored when the emergency is past.

Domestic consumers include the users of gas for heating, lighting and cooking in private homes and apartments, but for lighting and cooking only in hotels, restaurants, etc. Industrial consumers are divided into three classes, comprising (1) plants producing food on a large scale, (2) power plants with gas engines, and (3) those not included in the first two classes. When there is not sufficient gas for all consumers, the surplus is to be furnished to them in the order above named. If, after disconnecting all industrial consumers, there is not a sufficient supply for the domestic consumers, there is to be a limited curtailment of use for heating purposes which, as the supply becomes much more restricted, will make it incumbent for householders to install auxiliary heating equipment.

A further recommendation, emphasized also by the National Committee, is that all distributing companies make a study of the best and most economical methods of using natural gas, and that a campaign of education be carried on among consumers. This thought was further advanced in a proclamation issued by the Governor of Ohio.

In the same spirit was a conference held in September at White Sulphur Springs, West Virginia, attended by the public-service commissions of the gas-producing states and representatives of the leading gas companies and gas associations. Definite recommendations were made to the natural-gas companies for the coming winter, calling for more efficient domestic gas appliances and classification of domestic and industrial consumers, and a survey of the territory served by the different companies.

Still another phase of the situation is the law recently passed by the State of West Virginia, known as the Steptoe Law, which provides that the natural gas produced in West Virginia may not be used outside of the state until after all the requirements and demands of home consumers had been supplied. This law has been contested by the states of Ohio and Pennsylvania to enjoin West Virginia from enforcing their law, and the case is now pending in the Supreme Court of the United States. At a recent hearing, Mr. S. S. Wyer, Mem.Am.Soc.M.E., natural gas engineer for the U. S. Bureau of Mines, opposed the West Virginia law.

At the conference at White Sulphur Springs, Prof. I. C. Church, state geologist of West Virginia, testified that from 75 to 90 per cent of gas deposits in Ohio are gone, and three-quarters of the known gas territory in West Virginia is already exhausted. The necessity for conserving the remaining available supply for the benefit of domestic consumers makes it apparent that the use of natural gas for industrial purposes must ultimately be discontinued; even at present there are occasions during periods of extreme cold when the gas supply is insufficient for domestic consumers alone, which indicates that gas for house heating will have to be restricted in order to conserve the supply for cooking and hot-water heating.

The Water Power Act

With the passage of the Water Power Bill during the last session of Congress, the way has at last been cleared for the development on a large scale of a hitherto neglected source of power. It is true that in the past there has been some utilization of our water-power resources, but for the most part it has been confined to limited sections of the country. While this condition can be traced in part to the low costs of fuel and transportation which formerly prevailed, the controlling factor, nevertheless, has been the limitations imposed by the Government restrictions growing out of the fear of the usurpation of national resources by private interests.

Heretofore Government permits for the development of water-power sites have been revocable at will, and thus the business world has hesitated to embark upon such ventures. The new water-power bill, however, removes this uncertainty, as licenses will now be granted for a term of fifty years and at the end of such time may be renewed; or the Government, if it sees fit, may take over the development, giving, of course, proper compensation to the owners. Such a provision cannot fail to encourage investors.

By the passage of the bill water power now comes to the fore as a national resource of the greatest importance, and to the end that its readers may be kept in touch with the latest developments in this field, Mechanical Engineering presents elsewhere in this issue a summary of the regulations governing the administration of the newly enacted law.

Ground Broken for Vehicular Tunnel Between New York and New Jersey

On October 12, 1920, at Canal and Washington Streets, New York City, the first ground was broken for the vehicular tunnel to be built between New York City and Jersey City. The ceremony was held under the auspices of the New York State Bridge and Tunnel Commission, George B. Dyer, Chairman, and The New Jersey Interstate Bridge and Tunnel Commission, W. H. Noyes, Chairman.

The first work to be done on the tunnel is the construction of two ventilating shafts at the Manhattan end of the tunnel, located respectively at Canal and Spring Streets, near Washington Street. These shafts, which are 60 ft. and 54 ft. deep, respectively, will form permanent ventilating openings connecting with the tubes. The specifications show few material differentiations from the former practice in New York subway work. The chief change is in waterproofing, cotton fabric and asphalt being specified instead of burlap and coal-tar pitch because it is thought that the hot asphalt in compressed air will give less trouble in the matter of fumes than the coal-tar pitch. C. M. Holland, chief engineer, states that the type of ventilating shaft specified makes it feasible for the subsequent tunnel work to be done either by the shield process or by the trench method.

High-Speed Machinery

Under the Survey of Engineering Progress in the present issue is described a single-stage air compressor, operating at a normal speed of 22,000 r.p.m., which has been shipped by an American concern to South America. In many respects this is a significant installation. The very fact that a device of this character has been adopted for use in South America, where repair facilities are comparatively scarce, and not always adequate, shows the confidence both of its makers and purchasers in the reliability of the apparatus, notwithstanding the fact that it runs at such great speed.

Great speeds of rotation such as now met with in different types of apparatus have been achieved only by satisfying certain previously prescribed conditions as to materials, workmanship and means for balancing, etc. When it is stated that in the blower referred to, one ounce at the tip of the rotor exerts a stress due to centrifugal forces equal to something like $3^1/_2$ tons, it will be realized that not only materials capable of withstanding these immense stresses must be used, but also materials not subject to fatigue within extremely severe limits; and still further, methods of producing parts that will insure a very great range of safety.

Special steels, such as nickel-chrome and nickel-chrome-vanadium, together with great skill and care in the manufacture of ferrous alloys, have solved the problem as to the raw material, while, in the instance mentioned, modern methods of forging enabled the shaft and blades to be produced out of a single piece, which helped materially in the direction of necessary excellence of workmanship.

But before these tremendously high-speed machines could be made commercially practicable, a good deal of research in the field of mechanics of fast-revolving parts had to be done. It is only within the most recent time that engineers have succeeded in obtaining a clear comprehension of the laws governing the critical speeds of shafts, whirling phenomena, and the balancing of rotating parts generally, and have evolved methods for observing and measuring dynamic unbalance and for correcting errors therein. This was a somewhat tedious research, requiring an unusually skilful use of both mechanical and mathematical tools of investigation, and the success of modern high-speed machinery shows how well this work has been accomplished.

It should be clearly understood that the use of machinery running at speeds of 20,000 r.p.m. and upward is not merely an engineering "stunt" but is an answer to a very urgent requirement. In some cases, as, for example, with blowers, it permits a more compact design of machine and achieves in a more efficient manner what could also have been done with slower-running machinery. On the other hand, there are cases where a problem can be solved only by the use of such high-speed machinery, as, for example, in the case of the Alexanderson high-frequency generator for wireless telegraphy. There is another class of electric generators, namely, the commutatorless direct-current generator, where the ability to run at these high speeds appears to be a valuable characteristic. The significance of such machines as the DeLaval blower and the Alexanderson high-frequency generator for wireless telegraphy lies just as much, however, in the fact that it shows to what a state of perfection modern engineering has arrived in the production of materials and parts capable of withstanding truly tremendous stresses, and in the comprehension of the hitherto obscure phenomena of dynamic balancing and critical speeds of fast-rotating parts.

A natural-gas primer has been issued by the State of Ohio for use in its public schools. This pamphlet, which was originally issued by the U. S. Fuel Administration, deals in the simplest manner possible with the production and distribution of natural gas, the need for its conservation, and its economical use in the home.

Federal Power Commission Adopts Regulations

Commission Charged With Administering the New Federal Water Power Act Announces Adoption of Ten Rules Covering Procedure to be Followed in the Securing of Licenses and Permit

THE Federal Power Commission, which is charged with administering the Water Power Act, has adopted a set of comprehensive regulations covering the procedure in connection with the securing of licenses and permits. These regulations, ten in number, are of vital importance to the work of the Commission, as already many applications have been received, and if the present rate is maintained they will total before January 1 at least 4,000,000 horsepower.

The regulations just issued cover such matters as (1) Definition of Terms, (2) Applications—General Requirements, (3) Applications for Preliminary Permits, (4) Applications for Licenses—Major Projects, (5) Applications for Licenses—Minor Projects, (6) Applications for Licenses—Major Projects Already Constructed, (7) Declarations of Intention, (8) Priorities, (9) Permits, and (10) Licenses. Regulations (9) and (10) are of particular importance to those interested, and for that reason are given below in full.

The passage of the Federal Water Power Act concludes twelve years of effort for satisfactory water-power legislation. In accordance with its provisions the Secretary of War, the Secretary of the Interior, and the Secretary of Agriculture became a Commission to administer the Act and at their first meeting the Secretary of War was appointed chairman and O. C. Merrill, who at that time was chief engineer of the Forest Service, was made executive secretary.

The work of the Commission has been divided into engineering, accounting, statistical, regulatory, licensing, legal, and operation. The engineering division is regarded as the most important as it will make general investigations of the electric power industry, power sites, costs and developments. It will also report results of its examinations to Congress preparatory to construction work of the United States; examine and revise plans for development of streams upon which applications for licenses are made; consider construction plans proposed by licensee; and when already existing plants are brought under the Act will fix the necessary stipulations as to maintenance, development, and operation.

(9) PERMITS:

A—Except as hereinafter provided, preliminary permits may be issued on the application of citizens, associations, corporations, States or municipalities desirous of obtaining licenses for the construction, maintenance or operation of dams, water conduits, reservoirs, power houses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation, and for the development, transmission and utilization of power across, along, from or in any of the navigable waters of the United States, or upon any part of the public lands and reservations of the United States (including the Territories), or for the purpose of utilizing the surplus water or water power from any Government dam.

B—Permits will be issued only for the purpose of enabling applicants to maintain their priorities while securing the data required for an application for license and will be for such periods, not exceeding a total of three years, as in the judgment of the Commission will be necessary for studying the proper location and design of the project; for making examinations, surveys, maps, plans, specifications and estimates; for conducting stream measurements; for sinking test pits or making borings to determine foundations for dams or other structures; for securing a market for the power to be developed; for making financial arrangements; or for any other purpose necessary or desirable in the preparation of application for license.

C—Permits will not be issued for projects already constructed; for transmission lines alone; for projects of a power capacity of less than 100 horse power; for projects which, in the judgment of the Commission, do not come within the scope of its authority under the Act, or should be undertaken by the United States itself, or do not propose adequate schemes of development, or would unreasonably interfere with projects under permit, license or other authority theretofore granted; or for projects for which date sufficient for filing application for license are already available. Permit affecting any reservation will be issued only after a finding by the Commission that the proposed use will not interfere or be inconsistent with the purpose for which such reservation was created or acquired. Permits will not be issued until after the expiration of the publication period prescribed by the Act.

D—In acting upon applications for preliminary permits, and in determining preferences therefore, the Commission may in its discretion upon the request of any applicant or upon its own motion, hold hearing, order testimony to be taken by deposition, summon witnesses, or require the production of documentary evidence.

E—No charges will be made for permits, but permittees will be required as a condition of maintenance of priority, to perform such work and to make such studies and investigations, and such reports thereon, as in the judgment of the Commission may be necessary or desirable to enable both the applicant and the Commission to determine the feasibility, and the character and extent of development, which is proposed or which should be undertaken, which requirements will be expressed in the permit.

F—Upon a satisfactory showing of reasons, therefore, the Commission may authorize permittees to perform such construction work as may be necessary to maintain water rights under State law, or as may be desirable in preparation for the construction of project works; but the granting of such authority shall not be deemed to have created any equities or to have established any rights beyond what would have been created or established had such authority not been given.

H—Each preliminary permit shall set forth the conditions under which priority shall be maintained and a license issued, and shall also set forth the essential terms and conditions of such license.

(10) LICENSES:

A—Except as hereinafter provided, licenses may be issued either in accordance with the provisions of preliminary permits or upon direct application therefore by citizens, associations, corporations, States or municipalities, for the purpose of constructing, operating, and maintaining dams, water conduits, reservoirs, power houses, transmission, and utilization of power across, along, from or in any of the navigable waters of the United States, or upon any part of the public lands and reservations of the United States (including the Territories), or for the purpose of utilizing the surplus water or water power from any Government dam.

B—Licenses will be issued for such periods, not exceeding fifty (50) years, as in the judgment of the Commission, will in each individual case, allow for the satisfactory development and operation of the project and protect the public interest, and shall remain in full force and effect for such periods unless surrendered or terminated as provided in these regulations or revoked as provided in the Act.

C—Licenses will not be issued for projects which, in the judgment of the Commission, do not come within the scope of its authority under the Act, or should be undertaken by the United States itself, or do not propose adequate schemes of development, or lack satisfactory showing of financial ability, or would unreasonably interfere with projects under permit, license or other authority theretofore granted, or would be opposed to the public interest. No license affecting the navigable capacity of any navigable waters of the United States will be issued until the plans of the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of War. Licenses within any reservation will be issued only after a finding by the Commission that the license will not interfere or be inconsistent with the purposes for which such reservation was created or acquired. Licenses will not be issued until after the expiration of the publication period prescribed by the Act.

D—Licenses may be altered only upon mutual agreement between the licenses and the Commission. Any such alteration shall be made a part of the license and a substitute for the provision altered, but no such alteration shall operate to alter or amend or in any way whatsoever be a waiver of any other part, condition, or provision of the license.

E—Licenses may be surrendered only upon mutual agreement between the licensee and the Commission, and upon the fulfilment by the licensee of all obligations under the license, with respect to payment or otherwise, existing at the time of such agreement, and, if the project works authorized under the license are constructed in whole or in part, upon such conditions with respect to the disposition of such works as may be determined by the Commission.

F—Licenses may be terminated by written order of the Commission after such reasonable notice, not exceeding ninety (90) days, as the Commission may grant, if there is failure to commence actual construction of the project works within the time prescribed in the license, or as extended by the Commission. Under similar conditions and upon like notice the authority granted under a license may be terminated with respect to any project works or separable part thereof covered by the license, if there is failure to begin construction of such project works or part thereof within the time prescribed in the license or as extended by the Commission; but no part of the project works shall be deemed separable for the purposes of this regulation unless so specified in the license.

G—Licenses may be revoked only through proceedings in equity instituted in a district court of the United States for a district in which some part of the project is situated, and in the manner provided in the Act: (*a*). In case construction of the project works covered by the license, or of any specified part thereof, has been begun but not completed within the time prescribed in the license, or as extended by the Commission; or (*b*) in case the terms of the license are violated by the licensee.

Plans for A.S.M.E. Annual Meet

Meeting in New York December 7-10 to Consider Vital Transportation Problem—Newly
cations to Woodworking and a Number of

THE tentative plans for the Forty-first Annual Meeting of The American Society of Mechanical Engineers to be held in New York early in December are prophetic of the best meeting in the history of the Society. The main points which assure success lie in the importance of the topic selected for the Keynote Session and in the fine spirit of coöperation shown by the newly formed Professional Sections, which will present many valuable and interesting papers.

Keynote Session

Transportation will be the subject of the Keynote Session. Industry in this country is being severely handicapped because of the lack of adequate transportation facilities, and from present indications it will take several years for these facilities to catch up with the increased traffic and the normal development which will take place within the next few years.

Several phases of the transportation question will be considered on a broad, economic basis and with a view to developing practical constructive measures for improving the conditions. Addresses will be made on the railroad situation; water transportation, including rivers, lakes and canals; motor-truck transportation; terminals and freight handling; the Greater New York transportation problem; the development of railroad feeders; and a general address in the nature of a résumé or study of the whole transportation question in a large way.

Sessions of the Professional Sections

Six of the newly formed Professional Sections have presented plans for vitally interesting sessions at this meeting. This mobilization of engineering skill for the discussion of the problems in the various subdivisions of mechanical engineering has greatly increased the value of the meeting.

FUEL SECTION

The fuel situation of the United States demands careful attention by every individual, and help in conservation can be secured only by application of engineering principles. These points are clearly brought out in the four papers to be presented by the Fuel Section at the Annual Meeting, the following abstracts of which indicate the broad view-points of the authors.

THE FUEL SUPPLY OF THE WORLD, by L. P. Breckenridge.[1] This paper presents the latest available data on supply, production and use of various fuels of the world, particularly of the United States. It dwells primarily on supplies of various kinds of coal: anthracite, bituminous, lignite and peat. The problems of diminishing supply of natural gas and oil are discussed. The writer also touches on the evident impossibility of ever developing any considerable amount of water power in proportion to the total power requirements of that portion of the United States lying east of the Mississippi River. The paper closes with a plea for thrift in the use of coal, setting forth how in a broad way the waste of fuel may be prevented.

FUEL CONSERVATION, by David Moffat Myers.[2] The results secured by the constructive conservation of fuel during the war, a program based on hurriedly formed and necessarily imperfect plans, are an indication of what might be accomplished by thorough and complete plans for constructive conservation in peace time. Some of the main items of waste to be considered are found in (1) boiler plants; (2) coke ovens; (3) domestic heating equipment; and (4) plants and installations misusing steam after its generation. Under the last item the author considers the waste of exhaust steam. He emphasizes the need for coöperation between the private plants needing both heat and power and the central stations, which could supply both instead of wasting some 80 per cent of the heat of the steam into the condenser. In the case of the private plants producing a surplus amount of exhaust steam, more power might easily be generated and sold to the central-station system. Fuel conservation, the author states, can never be satisfied by development of the central-power-plant idea alone; the privately owned plant is essential to economy.

Touching on the "superpower" system advocated by W. S. Murray and included in a footnote to the paper, Mr. Myers believes that the plan as applied to railroads alone would have many important advantages but that in industrial and building heating the waste of steam and fuel in large central stations would be augmented rather than reduced.

Mr. Myers believes that the need of a definite policy of fuel conservation is urgent Natural gas is practically gone, it is estimated that the supply of natural fuel will be exhausted in 20 to 30 years, and coal, first anthracite and then bituminous, our last natural fuel resource, will be the next to disappear. The author advocates educating the public to the point where it will demand the coöperation of the Government in the conservation of fuel, and in conclusion he presents for consideration and constructive criticism a policy of fuel conservation to be adopted with the coöperation of the Government.

DISTILLATION OF FUELS AS APPLIED TO COAL AND LIGNITE, by O. P. Hood.[1] The necessity for conservation of both capital and raw material are two important factors restricting the distillation of coal. On the other hand, coal distillation is encouraged by the hope that if elements of higher value are recovered from coal by distillation, the remaining fixed carbon can be sold at a price lower than the raw fuel and also that by extensive distillation and other processes, manufactured gas may reinforce our rapidly disappearing natural gas.

Among the processes of distillation which are receiving considerable attention is that resulting from low temperature. The most advanced experiment in this country using low-temperature carbonization and distillation is the carbocoal process. In the production of metallurgical coke, distillation of coal in by-product coke ovens is already the major process.

The most favorable field for the expansion of distillation processes lies in domestic heating service. In lignite areas of the United States where there are large supplies of low-grade fuel and eastern coals are obtained with difficulty, experimental work has shown the possibility of applying distillation methods to this fuel, obtaining gas, tar, ammonium sulphate and a carbonized residue of excellent heating value.

FORM VALUE OF ENERGY IN RELATION TO ITS PRODUCTION, TRANSPORTATION AND APPLICATION, by Chester G. Gilbert[2] and Joseph E. Pogue.[3] Resource energy, as the source of power, heat, and chemical work, is the basis of industrial activity and social advancement. The quantity of energy required in the United States has grown to such stupendous size that its provision in the customary form is becoming increasingly difficult, as reflected in uncertainties of supply and rising cost. Coal, oil and water power—the major sources of energy—need each to be considered in regard to production, transportation and utilization; hence the problem assumes at once the complexity of a mathematical function with nine variables. The field of energy is an economic and technologic checkerboard, no area of which can be measured or appraised without due regard to all its associated components.

The energy situation is therefore reviewed in this paper from two points of view, that of "form value," defined as an intangible quality expressing the broad applicability of the energy form in contrast to its theoretical thermal value as commonly expressed in B.t.u. units; and "resource value," defined as an intangible quality expressing the availability of energy in terms of location and chemical character of its source, and involving the potentiality of chemical control for purposes of multiple production. Form value, in respect to both application and transportation, and resource value are discussed as basic factors in the development of a balanced energy supply. Industrial analogies contained in the paper furnish the reader with practical applications of the theory set forth.

RAILROAD SECTION

In preparing its program the Railroad Section desires to bring to bear the combined skill of its members in the advancement of ideas and information that will be of benefit to all railroad men of the country in the solution of their immediate problems. The program includes the papers which are abstracted below and gives ample opportunity for the discussion of situations through which railroad problems must pass before solution.

MODERNIZING LOCOMOTIVE TERMINALS, by G. W. Rink.[4] This paper is a discussion of the problem of providing adequate facilities for the proper maintenance of locomotives at engine terminals. The location, size and general layout is dependent on various elements, the two principal factors being character of work to be performed and location of the general locomotive repair shop. The necessity for

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ing Assure Phenomenal Success

Organized Professional Sections Have Planned Interesting Sessions—Engineering Appli-
Strong Miscellaneous Papers to be Presented

providing modern facilities is discussed with a view of awakening an interest in this subject, which has an important bearing on the ability of the railroads to handle the increased traffic demands of the country.

The introduction of modern labor-saving facilities not only makes for economy in repairs, but shortens the time necessary to prepare locomotives for service. The various structures which comprise the terminals are treated separately with more or less detail, having in mind that the entire problem must be handled in such a way that it will be of service in modernizing existing locomotive terminals as well as to provide information of value in designing new terminals.

Increasing the Capacity of Old Locomotives, by C. B. Smith.[1] The high cost of railroading makes this subject of increased importance at the present time. The usual policy with reference to the purchase of new locomotives and the conversion of old ones is not, in the opinion of the writer, a well-formulated policy. The difficulty lies in the fact that shop facilities are inadequate, a large amount of both time and money being consumed unnecessarily. The problems of adapting the old-type locomotives to suburban and local service are discussed and the items which are to be considered in any program for increasing locomotive capacity are listed. Mr. Smith cites examples of satisfactory reconstruction which justify the improvement program advocated by him, and states that the application of all the desirable auxiliaries to old engines is prohibitive without a radical provision for carrying out such a program.

Adjustment of Vehicles on Curves, by R. Eksergian.[1] The author gives a suggested outline of important factors that should be con-

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TENTATIVE ANNUAL MEETING PROGRAM

New York, December 7–10, 1920

(Other subjects or changes to be announced later)

Tuesday Afternoon, December 7 (Simultaneous Sessions)

FUEL SECTION

Fuel Supply of World, L. P. Breckenridge
Low-Temperature Distillation of Coal, O. P. Hood
Fuel Conservation Versus Money Conservation, D. M. Myers
Form Value of Energy in Relation to Its Production, Transportation and Application, Chester G. Gilbert and Joseph E. Pogue

WOODWORKING SECTION

Engineering in Furniture Manufacture, B. A. Parks
Use of Wood for Freight Cars, H. S. Sackett
Woodworking Educators, F. F. Moon
Wooden Hollow Ware, John L. Graham
Wooden Factory Flooring, L. T. Erickson
Wood Preservation, E. S. Park and J. M. Webber
Electrically Operated Sawmills, A. E. Hall

MACHINE-SHOP SECTION

Side Cutting of Thread Milling Hobs, Earle Buckingham

Tuesday Evening, December 7

Report of Tellers of Election and Introduction of the President-Elect
Presidential Address
Conferring of Six Honorary Memberships
Presidential Reception and Dance

Wednesday Morning, December 8

Business Meeting. Amendments to the Constitution, Reports of Standing Committees, Committees on Code of Ethics, Industrial Relations, Education, Feedwater-Heater Standardization, etc.

Wednesday Afternoon, December 8 (Simultaneous Sessions)

MANAGEMENT SECTION

The Life and Work of the late Henry L. Gantt
An Appreciation from France, M. Ch. de Freminville
An Appreciation from Great Britain, James J. Butterworth
Mr. Gantt's Contribution to Industry, Fred. J. Miller, Pres. A.S.M.E.
Mr. Gantt's Contribution to Shipbuilding, Ship Operation, Ordnance and Aircraft, Marshall Evans
The Culmination of Mr. Gantt's Work, E. A. Lucey
Mr. Gantt's Industrial Philosophy, W. N. Polakov

RAILROAD SECTION

Static Adjustment of Trucks on Curves, R. Eksergian
Increasing Capacity of Old Locomotives, C. B. Smith
Modernizing Locomotive Terminals, George W. Rink

RESEARCH

Calibration of Nozzles for the Measurement of Air Flowing into a Vacuum, Wm. L. DeBaufre
The Heat-Insulating Properties of Cork and Lith Board, A. A. Potter, J. P. Calderwood, A. S. Mack and L. S. Hobbs
The Flow of Fluids through Pipe Lines and the Effect of Pipe-Line Fittings, D. E. Foster
Steam Formulae, R. C. H. Heck

Wednesday Evening, December 8

Brashear Memorial. Oration will be delivered on the life and work of the late Dr. John A. Brashear, Past-President, A.S.M.E.

Thursday Morning, December 9

Keynote Session on Transportation. The following phases of the Transportation Problem will be discussed by authorities in this field: Railroads; Waterways; Feeders; Motor Trucks; Terminal Problem of New York City

Thursday Afternoon, December 9

Continuation of Keynote Session on Transportation
Ladies' Tea and Dance

Friday Morning, December 10 (Simultaneous Sessions)

DESIGN

Disastrous Experiences with Large Center-Crank Shafts, Louis Illmer
Tests on Rear-Axle Worm Drives for Trucks, K. Heindlhofer
Foundations for Machinery, N. W. Akimoff

TEXTILE SECTION

Humidity Control in Textile Plants, Author to be announced
Power Application to Finishing Plants, Leo Loeb
Textile Fabrication for Mechanical Purposes, J. W. Cox

POWER SECTION

Session Devoted to Consideration of Future Developments of Power

MISCELLANEOUS

The Constitution and Properties of Boiler Tubes, A. E. White

Other Papers to be Scheduled Later

sidered in the layout of a locomotive from the aspect of the adaption of the running gear to a plane curve. The paper considers in detail the following points: (*a*) The geometrical limitations imposed for a given curve with a proper wheelbase and the relation between lateral play and length of wheelbase, etc.; (*b*) the nature of the lateral reactions induced between the various elements of the running gear for various wheel arrangements and curves; (*c*) the elementary requirements in the design layout and arrangement of the wheelbase, together with the proper type of guiding trucks, etc.; and (*d*) the effect of the lateral reactions on the running gear as to strength of axles, etc.

Management Section

The program of the session of the Management Section has been drawn up with the purpose of summarizing the life work of Henry L. Gantt and crystallizing the principles thereof for the guidance of the engineer.

Of the speakers, President Miller has long been an apostle of management as expounded by Mr. Gantt and for several months previous to Mr. Gantt's death was associated with him. Mr. Evans served in the Emergency Fleet Corporation during the war and there had an opportunity to give Mr. Gantt's methods a thorough tryout. Mr. Polakov was intimate with Mr. Gantt and is able to successfully interpret the fundamentals of his philosophy. Mr. Lucey was long a member of Mr. Gantt's organization and directly in touch with his latest plans. Messrs. Butterworth and de Freminville were close students and great admirers of his life and work. The session will have an appeal not only to the disciples of Mr. Gantt but to every engineer in industry, for the engineer has been the first to realize that the industrial problem is a problem of "man," and the understanding is now general that Mr. Gantt was the pioneer in applying the humanizing influence to management problems.

Machine Shop Section

Papers on important points in machine-shop practice will be discussed, and although the valuable paper by Earle Buckingham on the subject Side-Cutting of Thread-Milling Hobs is the only one at present selected by the Committee, we are assured that other valuable contributions will be received which will make up a particularly strong session.

Textile Section

Although this Section has not been formerly organized, its members have shown great interest, and the session to be held at the Annual Meeting will bring out four papers of practical value to the textile manufacturers.

Power Section

At the time of going to press the plans for this session had not been entirely completed. However, the subject for discussion will be Future Power Developments. Its treatment will be from four points of view, as follows:

(*a*) The Policy of Future Power Development, covering broad general aspects of future development and placing emphasis on fuel conservation and elimination of uneconomical generating stations.
(*b*) Effect of Load Factors on Cost, dealing with the economy in operating and capital charges due to diversity of load factors.
(*c*) Effect of Size of Plant on Cost, treating of high economies possible in large plants.
(*d*) Financial and Legal Aspects of Future Power Development.

Miscellaneous

As has been announced previously in Mechanical Engineering, a session will be devoted to the discussion of the Principles of Engineering in Woodworking. This session will give detailed information as to the proper application of engineering to varied subjects of the woodworking industry, and will emphasize the great need for further application of engineering principles to this industry.

In addition to the miscellaneous Annual Meeting papers, copious abstracts of which are included in this issue of Mechanical Engineering, there will be presented a paper by N. W. Akimoff containing a detailed discussion of Foundations for Machinery. Mr. Roger M. Freeman will also present a paper giving the general layout of the $20,000,000 Naval Ordnance Plant at Charleston, W. Va.

Brashear Memorial

The greatness of Dr. John A. Brashear is worthy of fitting tribute by The American Society of Mechanical Engineers. With this in mind, Wednesday evening of the meeting week has been set aside for the honoring of a great man. An oration setting forth in form for permanent record the lovable qualities and successful attributes of "Uncle John" will be presented.

Thursday Evening

Attention is especially called to the action of the Meetings Committee in not scheduling a meeting event on Thursday evening. This program permits the holding of College reunions on Thursday night if desired and gives out-of-town members attending the meeting an opportunity to avail themselves of some of the various amusements which the metropolis offers.

History of Naval Consulting Board Just Issued

The Navy Department has just issued a 288-page book containing a history of the origin and accomplishment of the Naval Consulting Board. Created in 1915 by the Secretary of the Navy and headed by Thomas A. Edison, this organization played a conspicuous part in the development of war inventions and new devices.

The formation of the Board, it will be recalled, was effected with the aid of the national engineering and allied techinal organizations, who selected from their membership men especially qualified to form the personnel of such an important body. The American Society of Mechanical Engineers, for example, were represented by W. R. L. Emmet, a consulting engineer of the General Electric Company and Spencer Miller, of the Lidgerwood Manufacturing Company, whose work has been largely concerned with the design and production of marine apparatus.

The history of the Board was written by Lloyd N. Scott, late Captain, U. S. A., who acted as liaison officer to the Board and the War Committee of Technical Societies from the Invention Section of the General Staff, U. S. A. Special emphasis is laid on the fuel-oil investigation, the new naval station on the Pacific Coast, ship protection, the inventive accomplishments of the members of the board, and the meritorious inventions received from the public. Many of the special problems on which the Board worked in close coöperation with Army and Navy officials are also reviewed.

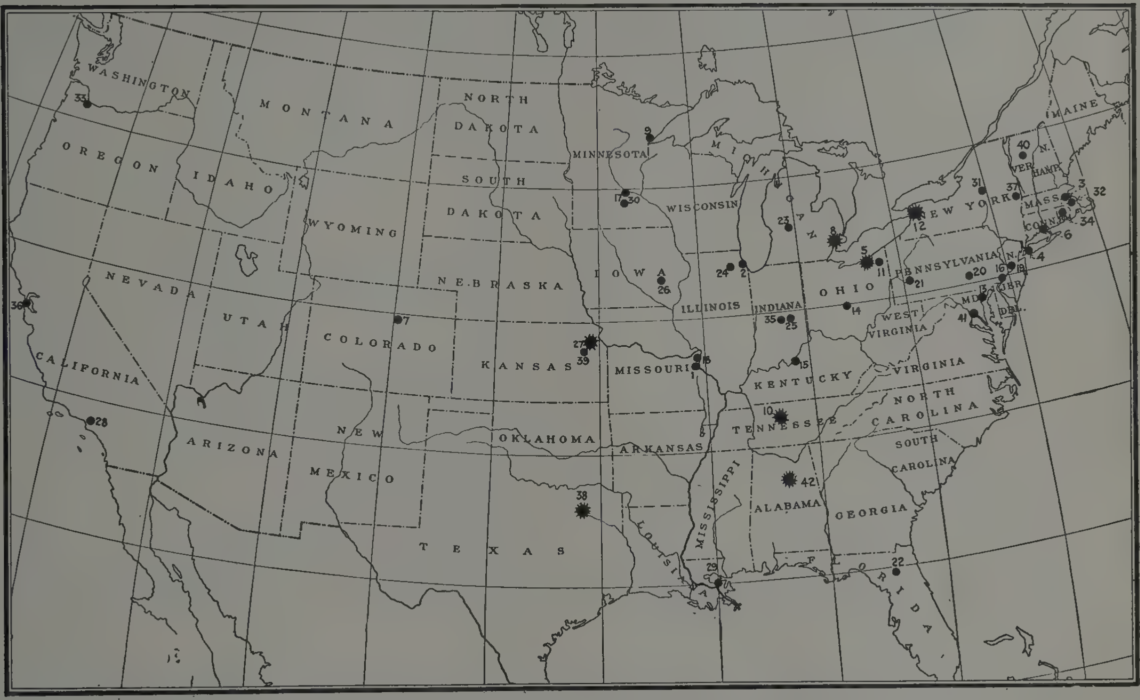
The preface to the volume comes from the pen of Secretary Daniels, who writes of the work of the Board in the following words:

> It would have been impossible for the Navy to have carried on its efficient part in winning the World War without the intelligent and patriotic contribution of civilian thinkers and workers as well as civilians who enlisted in every department of naval effort. Foremost among these civilian patriots stand the members of the Naval Consulting Board. Its members gave themselves fully to the service of their country, bringing scientific and engineering knowledge, with large experience touching the vital problems that confronted the Navy. The membership of this Board was chosen by and from the foremost engineering societies in America, embracing men whose achievements were of world renown. The Navy, indeed the whole country, owes their scientific patriotism a debt not only for what they wrought but quite as large a debt for the stimulus and inspiration they imparted to the naval personnel and to civilians enlisted in national service.

The Astoria Silk Mills of Astoria, L. I., have recently purchased the historic West Point Foundry, in Cold Spring, and will operate it with 700 employees. The foundry closed down a few years ago, after the A. B. & J. M. Cornell Iron Works had operated it for several years. The first locomotive used in New York State, the old wood burner De Witt Clinton, now on exhibition in Grand Central Terminal, was constructed there. The plant was rushed with war orders during the civil war making hundreds of Parrott guns.

The Federated American Engineering Societies Was Created To Consolidate The Engineering Organizations of America

Is Your Engineering Society a Member of This Federation?



The Field of The Federation
Circles Show Local Societies Represented at Washington Conference, June 3 and 4, 1920
Asterisks Show Local Societies Now Members of the Federation

Last June delegates from 30 national and 41 local and regional organizations met and created THE FEDERATED AMERICAN ENGINEERING SOCIETIES. It is a going organization and on November 18 and 19 the first meeting of its governing body, the American Engineering Council, will be held at Washington, D. C. Will your Society be represented? Consult the list below and see. The societies listed in bold-face type are those which are now members of the Federation.

ORGANIZATIONS REPRESENTED AT WASHINGTON CONFERENCE, JUNE 3 AND 4, 1920

Local, State; and Regional Organizations

(1)	Associated Engineering Societies of St. Louis, St. Louis, Mo	1,200
(2)	Associated Engineers of Spokane, Spokane, Wash	200
(3)	Boston Society of Civil Engineers, Boston, Mass	786
(4)	Brooklyn Engineers' Club, Brooklyn, N. Y	415
(5)	**Cleveland Engineering Society, Cleveland, Ohio**	**1,300**
(6)	Connecticut Society of Civil Engineers, New Haven, Conn	385
(7)	Colorado Society of Engineers, Denver, Colo	415
(8)	**Detroit Engineering Society, Detroit, Mich**	**575**
(9)	Duluth Engineers' Club, Duluth, Minn	154
(10)	**Engineering Association of Nashville, Nashville, Tenn**	**125**
(11)	Engineering Society of Akron, Akron, Ohio	436
(12)	**Engineering Society of Buffalo, Buffalo, N. Y**	**600**
(13)	Engineers' Club of Baltimore, Baltimore, Md	230
(14)	Engineers' Club of Columbus, Columbus, Ohio	250
(15)	Engineers' and Architects' Club of Louisville, Louisville, Ky	225
(16)	Engineers' Club of Philadelphia, Philadelphia, Pa	2,222
(17)	Engineers' Club of Minneapolis, Minneapolis, Minn	179
(18)	Engineers' Club of St. Louis, St. Louis, Mo	625
(19)	Engineers' Club of Trenton, Trenton, N. J	280
(20)	Engineers' Society of Pennsylvania, Harrisburg, Pa	702
(21)	Engineers' Society of Western Pennsylvania, Pittsburgh, Pa	1,200
(22)	Florida Engineering Society, Gainesville, Fla	162
(23)	Grand Rapids Engineering Society, Grand Rapids, Mich	85
(24)	Illinois Society of Engineers, Wheaton, Ill	262
(25)	Indiana Engineering Society, Indianapolis, Ind	225
(26)	Iowa Engineering Society, Iowa City, Iowa	358
(27)	**Kansas Engineering Society, Topeka, Kansas**	**205**
(28)	Los Angeles Joint Technical Society, Los Angeles, Cal	1,600
(29)	Louisiana Engineering Society, New Orleans, La	285
(30)	Minnesota Surveyors' and Engineers' Society, Minneapolis, Minn	200
(31)	Mohawk Valley Engineers' Club, Utica, N. Y	160
(32)	New England Water Works Association, Boston, Mass	890
(33)	Oregon Technical Council, Portland, Ore	330
(34)	Providence Engineering Society, Providence, R. I	830
(35)	Scientech Club, Indianapolis, Ind	120
(36)	San Francisco Joint Council of Engineering Societies, San Francisco, Cal	1,600
(37)	Society of Engineers of Eastern New York, Troy, N. Y	490
(38)	**Technical Club of Dallas, Dallas, Texas**	**125**
(39)	Topeka Engineers' Club, Topeka, Kansas	63
(40)	Vermont Society of Engineers, Montpelier, Vt	150
(41)	Washington Society of Engineers, Washington, D. C	482
(42)	**Alabama Technical Association, Birmingham, Ala**	**110**

National Organizations

(1)	American Association of Engineers, Chicago, Ill	20,000
(2)	American Association of Petroleum Geologists, Norma, Okla	250
(3)	American Ceramic Society, Alfred, N. Y	1,262
(4)	American Concrete Institute, Boston, Mass	450
(5)	American Electric Railway Engineering Association, New York, N. Y	800
(6)	American Electrochemical Society, Bethlehem, Pa	2,500
(7)	**American Institute of Chemical Engineers, Brooklyn, N. Y**	**318**
(8)	**American Institute of Electrical Engineers, New York, N. Y**	**11,345**
(9)	**American Institute of Mining and Metallurgical Engineers, New York, N. Y**	**8,689**
(10)	American Railway Engineering Association, Chicago, Ill	1,450
(11)	American Society of Agricultural Engineers, Columbus, Ohio	624
(12)	American Society of Civil Engineers, New York, N. Y	9,652
(13)	**American Society of Mechanical Engineers, New York, N. Y**	**12,705**
(14)	American Society of Refrigerating Engineers, New York, N. Y	400
(15)	American Society of Safety Engineers, New York, N. Y	456
(16)	American Society of Heating and Ventilating Engineers, New York, N. Y	1,203
(17)	American Society for Testing Materials, Philadelphia, Pa	2,765
(18)	American Water Works Association, New York, N. Y	2,616
(19)	Association of Railway Electrical Engineers, Chicago, Ill	450
(20)	Illuminating Engineering Society, New York, N. Y	1,250
(21)	Institute of Radio Engineers, New York, N. Y	1,600
(22)	Mining and Metallurgical Society of America, New York, N. Y	305
(23)	National Fire Protection Association, Boston, Mass	3,203
(24)	National Safety Council (Engineering Division), Chicago, Ill	200
(25)	Society of Automotive Engineers, New York, N. Y	4,869
(26)	**Society of Industrial Engineers, Chicago, Ill**	**400**
(27)	Society of Naval Architects and Marine Engineers, New York, N. Y.	1,688
(28)	Society of American Military Engineers, Washington, D. C	1,600
(29)	Society for the Promotion of Engineering Education, Pittsburgh, Pa.	1,525
(30)	Taylor Society, New York, N. Y	370

Engineering Division of National Research Council Issues Report

Research in the Future to be Conducted by a Special Committee in Each Field—Reorganization of Division Opens Way for Greater Coöperation with Industries and Engineering Organizations—Grouping of Existing and Proposed Committees

The Division of Engineering of the National Research Council recently rendered to Engineering Foundation, which coöperates with it in its work, a report of its accomplishments to date and the lines along which it expects to develop in the immediate future. As in the case of many other fields of endeavor, engineering research has been greatly handicapped by lack of funds, and Comfort A. Adams, chairman of the Division, emphasizes this fact in his report. He writes:

> The opportunities for service of great importance to our industries and to our country are almost appalling in number; but although the past accomplishments of our committees constitute a very considerable contribution toward such service, the progress in any particular case must be discouragingly slow, without substantial financial support. For example, the very substantial accomplishment of the Welding Committee was due in considerable part to the financial support of the Emergency Fleet Corporation, amounting to over $40,000 for one year. If all of our committees were supported on this same scale, by contributions from the interested industries, the annual contribution of any one company would be less than they pay in advertising during one month, and utterly insignificant as compared to the value of the results, as was true in the case of the Welding Committee.

Despite this lack of adequate funds, the Division has carried on research in many fields, and that its future undertakings may be productive, the work now in progress is being reorganized on the group basis; that is, in each general field there will be a General Advisory Committee, with a small, active Executive Committee, under which will be organized the several Research Committees. These General Advisory Committees will also be the agencies through which the Engineering Division will endeavor to stimulate the industrial world to conduct the more commercial forms of research. Furthermore, in order to enlist the active coöperation of the engineering societies, it is hoped to have each society accept as its own research committee the Advisory Committee in its particular field.

The grouping of the existing committees and of those in formation is shown in the accompanying chart. The first group (S) is largely made up of committees organized by Dr. H. M. Howe, formerly chairman of the Division, either during or shortly after the war. Several other committees of this group organized specially for war work, completed their work and were discharged. The committees on Non-Ferrous Metals (NF), Fatigue Phenomena of Metals (F), New Hardness-Testing Machine (HT), and Pulverizing (P), were likewise organized by Dr. Howe, and some of these might have been included in the Steel group, except that they apply also to non-ferrous metals.

All of these committees naturally come within the field of mining and metallurgy, and although they are not at present recognized as officially connected with the American Institute of Mining and Metallurgical Engineers, Professor Adams states in his report that it is expected they will be coördinated in the near future under a general group committee of that Institute.

It is similarly expected that the Electrical Group (E) and the Highway Group (H) will probably be accepted by the American Institute of Electrical Engineers and the American Society of Civil Engineers, respectively. None of the three societies mentioned above has research committees of its own. On the other hand, however, the group dealing with Mechanical Engineering (M) was organized by The American Society of Mechanical Engineers and is being administered and financed by that society.

The Alloy Research Association (AR) was first fathered by the Division of Research Extension and was intended to be an organization of the interested industries and, after it was well started, largely independent of the National Research Council. At present, however, its activities are confined to an information service and its management is attached to the National Research Council, the Engineering Division coöperating in this work.

The Society of Automotive Engineers is very much alive to the importance of research, but although some work has been done under its technical committees, the society is just now feeling its way in respect to the organization and conduct of research.

The Society of Heating and Ventilating Engineers is also actively engaged in research, most of its work being done at the Bureau of Mines' Pittsburgh Laboratory, under the direction of Prof. John R. Allen. The society has collected more than $20,000 per year from the industries for the conduct of this coöperative research, and the Bureau of Mines contributes space, facilities and assistance of about equal value. Several researches are actively under way at the present time.

The Society of Refrigerating Engineers is likewise thoroughly alive to the need for research, and although it has no research committee, it has appointed Professor Rautenstrauch, of Columbia University, as its representative on the Division, and he is now organizing for research in this field.

Engineering Division N.R.C.
- S-Steel (Metallurgy) (Advisory Committee A.I.M.E.)
  - S-1 Elimination of Inclusions
  - S-2 Elimination of Sulphur and Phosphorus
  - S-3 Heat Treatment
  - S-4 Physical Changes below the Thermal Critical Range
  - S-5 Substitute Deoxidizers
  - S-6 Steel Ingots
  - S-7 Neumann Bands
  - S-8 High-Speed Tool Steels
  - S-9 Effect of Sulphur and Phosphorus (Joint Committee under A.S.T.M.)
  - S-10 Magnetic Analysis of Steel (Representative on A.S.T.M. Comm. A-8)
- AR-Alloys Research Association (In cooperation with Division of Research Extension, N.R.C.)
- NF-Non-Ferrous Metals - - - - -
  - N.F-1 Uses of Tellurium and Selenium
  - N.F-2 Uses of Cadmium
- F-Fatigue Phenomena of Metals (Engineering Foundation)
- HT-New Hardness-Testing Machine
- P-Pulverizing
- E-Electrical (Advisory Committee A.I.E.E.)
  - E-1 Insulation
  - E-2 Core Loss
  - E-3 Radio Research
  - E-4 Heating of Electrical Machinery
- H-Highway - - - - - - - - - - - -
  - H-1 Economic Theory of Highway Improvements
  - H-2 Structural Design of Roads
  - H-3 Properties and Uses of Highway Materials
- M-Mechanical Engineering (A.S.M.E. Research Committee)
  - M-1 Lubrication
  - M-2 Bearing Metals
  - M-3 Heat Transfer
  - M-4 Cutting Action of Cutting Tools
  - M-5 Permanency and Accuracy of Engineering Instruments
- A-Automotive Engineering (S.A.E.)
- HV-Heating and Ventilating (A.S.H.& V.E.)
- R-Refrigeration (A.S.R.E.)
- W-American Bureau of Welding (American Welding Society)
  - W-1 Electric Welding
  - W-2 Gas Welding
  - W-3 Welding of Pressure Vessels (Cooperating with Boiler Code Committee of A.S.M.E.)
  - W-4 Welding of Storage Tanks

Finally, the American Bureau of Welding of the American Welding Society is also about to be reorganized as the General Advisory Committee on Welding to the Division of Engineering, although at present the research committees of the Bureau are officially committees of the Division.

CALIBRATION OF NOZZLES

(Continued from page 609)

greater the amount of moisture, the less the total weight of fluid that flows through the nozzle in a given time. Thus, when air flows through a nozzle from the atmosphere, the usual variations which occur in the amount of moisture contained therein produce appreciable changes in the weight of dry air admitted in a given time.

Based on an expansion exponent of $n = 1.375$, the rates of flow of dry air containing no moisture under the normal conditions of 70 deg. fahr. and 29.92 in. mercury pressure, 0.07492 lb. per cu. ft. density, have been calculated for the nozzles, calibrated, and are tabulated in Table 1.

Engineering and Industrial Standardization

The Standardization of Safety Codes

DURING the past ten or fifteen years many states have passed laws providing for the compensation by employers of workmen injured while engaged in the duties of their various occupations. These laws are administered by the state boards, usually called industrial accident boards or compensation commissions, and an organization of these boards has been formed called the International Association of Industrial Accident Boards and Commissions.

Some of these boards have not only administered the state laws respecting compensation but have also issued safety rules for use by the industries of their respective states. Such work is of great importance. Only a few states, however, have funds and technical staffs sufficient to independently prepare safety rules or codes and hence some states copy the rules of others with such changes as seem necessary or advisable, and promulgate them with such instructions and supervision as they are able to give. These rules are revised from time to time to make them more complete, and thus as each state has prepared and revised them considerable divergence has occurred, which has often proved embarrassing to manufacturers furnishing machinery and supplies which are expected to comply with the requirements of states having such rules.

As a step toward the elimination of this duplication the Bureau of Standards coöperated during the war with the War and Navy Departments in the preparation of several industrial safety codes for the use of the Government establishments. Furthermore, in order to get the judgment of all those most active in such work, the Bureau called a conference of approximately 100 organizations interested in safety codes. This conference was held in Washington, January 15, 1919. The special question put before it was how the work of preparing safety codes could be carried out so that they might become national and be generally used throughout the country. The suggestion was made that codes be submitted for the approval of the recently organized American Engineering Standards Committee, and at a second conference held on December 8, 1919, a resolution was passed that safety codes for general use should be prepared according to the procedure of that body.

A second resolution requested the American Engineering Standards Committee to ask the International Association of Industrial Accident Boards and Commissions, the National Safety Council, and the Bureau of Standards to form a Joint Safety Code Committee which should prepare a report giving a list of safety codes which should be prepared and recommending sponsors for the same. On January 3, 1920, the American Engineering Standards Committee took favorable action upon this request and formally asked these three organizations to form a committee.

This Joint Safety Code Committee was organized as an advisory committee to the American Engineering Standards Committee and has rendered valuable service. In its reports so far it has recommended the sponsorships for thirty-seven safety codes. Recent activities of a number of these sub-committees are given below.

Safety Code on Power Presses. The National Safety Council which has been assigned by the American Engineering Standards Committee the sponsorship for the Safety Code on Power Presses, has requested The American Society of Mechanical Engineers to appoint two representatives to serve on the Sectional Committee. The Society appointees are E. E. Barney, development engineer, Remington Typewriter Company, New York City, and C. N. Underwood, executive secretary of the Clothiers' Exchange of Rochester.

Safety Code for Grinding Machinery. The American Engineering Standards Committee has assigned to the Grinding Wheel Manufacturers' Association of the United States and Canada, and the International Association of Industrial Accident Boards and Commissions, the sponsorship for a Safety Code for Grinding Machinery. At the request of the Grinding Wheel Manufacturers' Association, Walter B. Gardiner, mechanical superintendent, Lincoln Twist Drill Co., Taunton, Mass., has been appointed to serve on this Committee.

Safety Code on Paper and Pulp Mills. The National Safety Council as sponsor for this code has requested The American Society of Mechanical Engineers to appoint two representatives to serve on this Committee.

Safety Code on Logging and Sawmill Machinery. The Bureau of Standards was appointed sponsor by the American Engineering Standards Committee to formulate a Safety Code on Logging and Sawmill Machinery. The Bureau of Standards has requested The American Society of Mechanical Engineers to designate a representative to serve on the Sectional Committee, and Joseph H. Dickinson, engineer, Lidgerwood Manufacturing Company, New York City, has been appointed.

Mechanical Transmission of Power. The International Association of Industrial Accident Boards and Commissions, the National Workmen's Compensation Service Bureau, and The American Society of Mechanical Engineers have been appointed joint sponsors for the Safety Code for the Mechanical Transmission of Power. The A.S.M.E. has designated the following members to serve on this Committee: A. C. Jewett, Winchester Repeating Arms Company, New Haven, Conn.; F. L. Morse, Morse Chain Company, Ithaca, N. Y.; G. M. Naylor, Fairbanks Company, New York City; R. W. Sellew, The Fafnir Bearing Company, New Britain, Conn.; E. D. Wilson, Graton & Knight Manufacturing Company, Worcester, Mass.; D. C. Wright, Dodge Manufacturing Company, Mishawaka, Ind.

International Aircraft Standardization

One of the most important organizations now concerned with standardization is the International Aircraft Standards Commission. This Commission is composed of representatives of Canada, France, Great Britain, and Italy. The admission of Belgium and Japan awaits formal confirmation, and needless to say the participation of America is greatly desired. The next meeting of the Commission will be held in Paris during November, and for the purpose of discussing America's participation therein a meeting was recently held in Washington, D. C., which was attended by the representatives of Government departments and national engineering organizations.

The meeting was called to order by A. A. Stevenson, chairman of the American Engineering Standards Committee, who stated that the organization which he represented had been requested to arrange for unofficial American representation at the Paris meeting of the Commission, if it were found impossible to secure full and official representation. Mr. Stevenson also stated that the Commission is planning to consider at the November meeting such general matters as the advisability of continuing on its present lines, its relation to whatever organizations should be set up by the Air Convention, and the consideration of reviewing or modifying the references to the Advisory Technical Committee.

After a full discussion of various methods which were proposed for bringing the matter to the attention of the proper Government officials, and what method should be followed in case Government credentials could not be secured, resolutions were unanimously passed authorizing the chairman to appoint a committee of not to exceed five to call on the chairman of the Council of National Defense and to present through him to the President a request for the authorization of official representation at the Paris Conference. The committee of five was also authorized to recommend in the event of favorable consideration of the request for official representation, that the American Engineering Standards Committee nominate members of the delegation who should represent this country.

The conference also went on record as favoring unofficial representatives, in the event that official representation cannot be secured, provided such a delegation would be permitted to sit in at the meetings of the International Commission, participate in the discussion, and be entitled to the report of the proceedings. It is also the sense of the conference that the American Engineering Standards commission, acting on behalf of the Conference, should appoint unofficial representatives.

NEWS OF THE ENGINEERING SOCIETIES

The Ninth Annual Safety Congress—Meetings of the Iron and Steel Electrical Engineers, American Society for Steel Treating, and American Chemical Society —The Sixth Chemical Exposition

Ninth Annual Safety Congress

That safety must be incorporated into the civic and school life and organized as a community activity is the 1920 slogan of the National Safety Council, under whose auspices the Ninth Annual Safety Congress was held in Milwaukee, September 27 to October 1. Over three thousand men and women delegates attended the congress. Two hundred exhibits in Mechanics' Hall showed every safety device on the market. The nineteen divisions of the council held sectional meetings, the sessions including those of engineering, public utilities, steam railroads, electric railroads, mining, rubber, metals, and the automotive industries. Motion-picture films on safety subjects were shown in the Milwaukee Auditorium during the days of the congress. Actual demonstrations by boy scouts of accident scenes which the safety workers had pictured verbally to the delegates, closed the program. From the point of view both of number of speakers and importance of the subjects discussed, this gathering was the most important in the history of the Council. Making safety a part of the instruction in public schools is the work upon which the Council plans to concentrate its energies in the immediate future. It is expected that the factory operative will thus have learned the principles of safety at an early age, and will be influenced by the instruction throughout his life.

Association of Iron and Steel Electrical Engineers

Recent developments in electrically driven reversing mills were recorded at the fourteenth annual meeting of the Association of Iron and Steel Electrical Engineers, held at the Hotel Pennsylvania, New York, September 24. A paper by K. A. Pauley on the Electric Reversing Mill Considered from the Standpoint of Tonnage gave an analysis of records on comparative runs in electric and steam mills showing that the electric mill can produce a tonnage equal to or greater than the steam mill. Coupling these records with the advantages of the electric mill from the standpoint of lower power costs, lower maintenance cost, greater flexibility of control, etc., there is little doubt that the steam reversing mill is now as out of date as the non-reversing steam mill has been for many years.

The educational committee suggested educating steel-mill electricians as to means for minimizing delays due to failure of electrical equipment in steel plants. Sample sheets of a practical electrical course being given to electricians in two large steel plants were included in the report of the committee.

The electric-furnace committee pointed out possible improvements in operating details of electric-furnace work. The report was prepared from answers received to a questionnaire sent out to steel manufacturers. The data secured indicate that the greatest need at present is for better electrode economy. Lack of tensile strength seems to be one of the difficulties of electrode trouble caused by the lines of cleavage of the calcined anthracite coal being in a vertical as well as horizontal direction, it being impossible at present to build an electrode where all the cleavage lines are horizontal. One of the chief sources of difficulty in furnace operation is delays due to handling material to and from the furnace. These can be reduced by bringing the scrap on the furnace floor from the rear and adjacent to the furnace in small cars on tracks and using traveling cranes entirely for handling the steel from the furnace.

In a paper on Some Economic Considerations in Design of Power Plants for Steel Mills, T. E. Keating studied in detail the utilization of blast-furnace gas and the efficiencies and costs that may be expected to prevail in such an installation. Power transmission was discussed by A. L. Freret in Underground Transmission, and by D. M. Petty in Transmission and Distribution of Power in Industrial Plants. A feature of the meeting was an exhibition on the roof of the hotel of representative types of electrical equipment for steel mills.

American Society for Steel Treating

The second annual convention of the American Society for Steel Treating was held in the Commercial Museum, Philadelphia, September 14–18, 1920, at which meeting the final steps of amalgamation between the Steel Treaters' Research Society and the American Steel Treaters' Society were consummated. Prof. A. E. White, of the University of Michigan, Ann Arbor, is president and W. H. Eisenman, of Cleveland, is secretary. The headquarters of the new society are at Cleveland.

The large floor space of the Commercial Museum was given over to an exhibition of various manufacturers of steel-treating devices and materials. A number of interesting sessions on the various phases of steel treating were held in the Assembly Hall. Among the noteworthy papers was that of H. P. MacDonald, vice-president, Snead & Co., Jersey City, N. J., who described a method of heat-treating aeroplane tubes by passing electric current through a tube to raise the temperature to the required degree, releasing the clamps holding the tube and allowing it to drop into the oil bath at the rate of one tube every 40 sec.

Dr. Charles W. Burrows, magnetic-research engineer, elaborated a method for the magnetic testing of rails, cables, etc., by which blowholes, flaws, seams, cracks, etc., would be revealed. Doctor Burrows showed that the method was commercial, inasmuch as only one minute was required per rail.

T. D. Lynch, of the Westinghouse Co., presented a tentative specification for the manufacture of helical springs required to transmit the power from a motor-driven quill, through a flexible coupling, to the driving wheels of a heavy electric locomotive. The analysis suggested is as follows: C, 0.50 to 0.60; Mn, 0.60 to 0.80; Si, 1.90 to 2.20; P, 0.04 max.; S, 0.04 max.

The properties of a highly resistant alloy steel were explained by Charles M. Johnson, director of research department, Crucible Steel Co. It is a complex alloy, with 0.3 to 0.4 per cent carbon, which reverts to a homogeneous solid solution upon annealing at 1300 deg. cent., and which, upon tempering being continued for several days, allows an excess constituent to divorce itself and become spheroidized. It is quite non-magnetic and resists staining and rusting remarkably. Although the metal can be forged, rolled or sheared in thicknesses 0.1 in. to 1 in., and is machinable, it offers a maximum resistance to prolonged heating at temperatures up to 2000 deg. fahr. and is cut by the oxy-acetylene torch with the utmost difficulty.

Metallurgical features of the manufacture of stainless steel articles were given by W. H. Marble, manager of American Stainless Steel Co. The analysis used is: C, 0.20 to 0.40; Cr, 13; Si, 0.30; Mn, 0.50. Chromium is the essential element furnishing the peculiar resistance to corrosion, tungsten and nickel being sometimes added for an increasing luster in polish. Ingots are box-annealed at 1380 deg. fahr., air-cooled, reheated to 2100 deg. fahr., and hammered carefully, never allowing the temperature to drop below 1650 deg. fahr. Cooling after forging gives hard material, the higher the uninterrupted cooling the harder becoming the material. Rough forgings are now reannealed at 1380 deg. fahr., using all the precautions necessary for high-grade steel, furnace-cooled to 1100 deg. fahr. and then air-cooled. This results in a Brinell hardness of 200. After machining and finishing the piece may be hardened from 1750 deg. fahr. in air, oil or water, depending upon the intricacy of the shape, and tempered at a suitable heat, varying from 280 deg. fahr. for knife blades to 1100 deg. fahr. for exhaust valves.

Other papers covered the Use of Quenching Fluids, the Development of Alloy Steels, and Various Fuels for Heat Treating, and symposiums were held which dealt with Case Carburizing and High-Speed Steel Treatment.

American Chemical Society

At the meeting of the American Chemical Society in Chicago, September 6 to 10, a fuel symposium was held at which a number of papers were presented of interest to mechanical engineers. The following notes on this session are abstracted from the report in *Power Plant Engineering* for October 1.

Dr. Harry A. Curtis described the process of manufacture of "carbocoal," the new smokeless fuel manufactured from bituminous coal and having certain of the characteristics of anthracite. It is prepared by crushing the soft coal and carbonizing it at the relatively low temperature of 900 deg. fahr. During the carbonization, which is carried out in a horizontal retort lined with carborundum, the coal is continuously stirred and moved slowly through the retorts by means of paddles mounted on steel shafts running lengthwise through the retort. A soft semi-coke is obtained from this low-temperature carbonization. The yield in tar is twice as much as is obtained from the ordinary coking process.

The semi-coke is ground, briquetted with pitch, and the briquets then carbonized for about six hours at 1800 deg. fahr. High-temperature carbonization renders the briquets hard, dense and smokeless. By-products are also obtained from the second carbonization. The first commercial plant manufacturing carbocoal was put into operation at Clinchfield, Va., in June 1920, and is equipped with 24 retorts giving a capacity of 500 tons of coal a day, from which 350 tons of the fuel are made. The process is the result of five years' experimental work at Irvington, N. J., and the large plant at Clinchfield was established as a war project.

Colloidal fuels were discussed by Dr. S. E. Sheppard. He recorded as a signal technical triumph the successful operation from April to July 1918, of the U. S. S. *Gem* on a colloidal fuel containing 30 per cent pulverized coal. Among the advantages he quoted for colloidal fuels were that they contain more heat units per gallon than fuel oils and very little moisture and ash, and that they are immune from spontaneous combustion and may be fireproofed by a "water seal" because they are heavier than water.

The development and increasing use of the by-product coke oven in the United States were dealt with by F. W. Sperr, Jr., and E. H. Bird. Before the war, coke was made largely in the simple beehive oven where tars run to waste and gases are discharged into the air. Now the by-product ovens lead the beehive ovens. The coking of a ton of high-grade coal in a beehive oven requires the consumption of 11,000 cu. ft. of gas, 9 gal. of tar, 4 gal. of light oil and 100 lb. of coke, which in all generate 9,388,000 B.t.u., or the equivalent of 671 lb. of coal. The by-product oven in making a ton of coke uses 4300 cu. ft. of gas, which is equal to 2,408,000 B.t.u., or equivalent to 172 lb. of coal.

Dr. J. B. Garner advocated the enrichment of illuminating water gas with natural gas as a means of economy. In this way, he said, natural gas could be so used as to insure to the public for many years to come a supply of gas at a cost at which it would otherwise be impossible to sell it.

Low-Temperature Carbonization and Its Application to High-Oxygen Coals, by S. W. Parr; Carbonization of Canadian Lignite, by Edgar Stansfield; Gasoline Losses Due to Incomplete Combustion in Motor Vehicles, by A. C. Fieldner, G. W. Jones and A. A. Straub; and Fuel Conservation, Present and Future, by Horace C. Porter, were subjects also considered at the fuel session.

Numerous other professional papers were presented at the other sessions. Attention may be called to the following: Electrometric Method for Detecting Segregation of Dissolved Impurities in Steel, by Edward G. Mahin and R. E. Brewer; Flow of Viscous Liquids Through Pipes, by Robt. E. Wilson and M. Seltzer; and Comparative Study of Vibration Absorbers, by H. C. Howard.

At the meeting of the council of the society the invitation to join The Federated American Engineering Societies and to send delegates to the coming meeting of the American Engineering Council was declined. It was held that the society should offer the Federation aid and encouragement, but that the fields of chemists and engineers were distinct and separate and that more and better work could be accomplished without interlocking the organizations in these branches.

Sixth Chemical Exposition

A multitude of products, comprising the most delicate instruments of precision, new chemicals and dyes, and a vast amount of machinery, displayed by nearly 500 exhibitors at the Sixth National Exposition of the Chemical Industries held in the Grand Central Palace, New York, September 20 to 25, afforded tangible evidence of the continued progress of the chemical and dye industries of the United States since the termination of the war. The exposition was formally opened with an address by Dr. Charles H. Herty, who said that during the past fiscal year our exports of chemicals totaled $1,250,000,000, of which $24,000,000 represented dye materials. Dr. Herty also outlined the growth of industrial research. Conservative estimates place the amount to be expended this year on industrial research laboratories, personnel, housing and equipment, at $25,000,000. He cited the example of a plant where industrial research had been instrumental in developing increased production, which suggested to him the possibility of overcoming the present inefficiency of labor through research on improved methods of operation in all lines of industry.

Dr. H. E. Howe, chairman of the Division of Research Extension, National Research Council, emphasized the fact that research plays a vital part in industrial conservation and cited the example of a certain mill in the application of modern bleaching methods. A reaction that was thought to take thirty hours for its completion was found to go forward under properly controlled temperature and pressure in three-quarters of a minute, so that but one-fifteenth of the capital was required to provide apparatus and stock formerly tied up in the process.

Dr. Howe also discussed the conservation of materials and the elimination of industrial waste through scientific control of processes. He related how steel mills were unable to make the type of billet which certain customers wanted until they had made their control more rigid. He took up, also, the question of protecting stores of both raw and finished products and again looked to scientific research for needed improvements. While much has been done there is still much more to be accomplished, and to this end the National Research Council has been organized with the coöperation of the national scientific and technical societies, many independent specialists, educational institutions and scientists employed by the Government.

Symposiums were held on fuel economy, industrial management, materials handling, chemical engineering and ceramics. Interest was enlivened by providing in connection with the papers extensive programs of motion pictures illustrating a wide range of chemical operations. R. C. Beadle, chairman of the Fuel Session, spoke on the duties and responsibilities of the combustion engineer in the present fuel crisis, and W. O. Rankin spoke on the use of pulverized fuel. Other papers at this session were: Saving Fuel by Controlling Chimney Losses, F. F. Uehling; Fluid Heat Transmission, Alexander B. McKechnie; Producer Gas and the Modern Mechanical Producer, W. B. Chapman; Refractory Cement: Life Insurance for a Furnace, F. W. Reisman; Preventing Conduction and Radiation Heat Waste, S. L. Barnes; Increasing Conduction and Reducing Fuel Consumption, W. R. Van Nortwick; The Reason for the Fuel Saving in the Dressler Kiln, Conrad Dressler.

The advance of the United States coal-tar chemical output in 1919 was recorded by Grinnell Jones, chief chemist, United States Tariff Commission. The productive capacity of the by-product coke ovens in the United States increased 17.2 per cent during 1919. With the possible exception of anthracene, adequate supplies of the fundamental raw materials of coal-tar origin will be available from American sources for the growth of the industry. The difficulty with anthracene is that its removal leaves the pitch so hard that it does not find a ready market under American conditions. Active work on the solution of this problem is now under way and the progress already made is encouraging. A comparison of the intermediates produced in 1918 and 1919 shows a considerable increase in the total number and substantial increase in amount in many cases. In 1919 there were about 225 different intermediates produced, against about 140 in 1918.

The session on Materials Handling, of which Roy V. Wright, Chairmam Committee on Meetings and Program, Am.Soc.M.E., acted as chairman, showed the influence on the cost of living of the use of costly methods of handling materials in the factory and at the terminal points. In speaking of the transportation problem Mr. Wright, in illustrating the economy resulting from handling goods by machinery, pointed to the fact that the shipper and the consumer have the cars 2.6 times as long as the railroad actually requires for hauling them. If mechanical means were provided to supplement the human factor and increase the average output, he observed, it would be possible to do this work much more quickly, and thus relieve the congestion at the terminals and keep the equipment moving for a proportionately greater time each day.

J. H. Leonard contrasted the perfection of the American railway machine with the "disgraceful" situation in the terminals. The roadbeds are the very best, the tracks are the fullest fruits of metallurgical science, bridges are substantial, rolling stock and motive power are the last words in design and construction, freight trains move expeditiously between points; but there perfection comes to an end. At the terminals trouble and expense begin, congestion quickly follows, with the result that terminal handling costs far exceed the cost of movement. Mr. Leonard saw no relief in sight with the recent announcement by the railroads that they propose spending nearly all of the enormous sums to come from the rate advances in the purchase of freight cars and locomotives. New cars, he added, would mean nothing more than floating storehouses, for the terminals could not handle the freight that would come to them. The solution of the problem, according to Mr. Leonard, must be worked out with the coöperation of almost every branch of engineering, for it is a case of specific adaptations to specific requirements which a survey and study alone can properly determine.

Two other papers were presented at the materials handling section, namely, Bringing the Food to the Table, by Rumsey W. Scott; and Cost Cutting with Conveyors, by W. T. Spivey. Of mechanical engineering interest were also the following papers which were presented at the other sessions: Recoverance: A Physical Property in Material and Its Importance, by Robert G. Guthrie; A Classification of Sheet-Steel Enamels, by R. R. Danielson; and Refractories, by Homer F. Staley.

HEAT-INSULATING VALUE OF CORK AND LITH BOARD

(*Continued from page 626*)

reading in Fig. 3. This key represents a section through the test box and shows the points at which temperatures were measured, together with the reference number to the thermometer.

The principal temperature readings obtained in the tests of Series 1 and 2 are shown graphically in Figs. 3 and 4, the results being plotted on logarithmic coördinates. Fig. 5 represents the final results of the conductivity and heat transmission of the two materials tested.

Conclusions

The results of these tests are of special interest because of the low value of the external temperature, the average for all tests being approximately 10 deg. fahr. The mean temperature of the materials tested was approximately 40 deg. fahr.

These tests indicate that the heat-insulating property of cork board is slightly better than that of lith board. For the samples tested the lith board has a conductivity approximately 5 per cent greater than that of cork board.

The conductivity and heat transmission of the materials tested increases with the temperature. The change is small, however, between the temperature limits employed in this investigation.

Any discrepancies in the results are more likely to occur at the lower heat inputs with their consequent small temperature differences.

Small differences in temperature materially reduce the heat flow. Under such conditions the rate of change in the adjustment of temperatures is likewise small and it is easily possible to assume conditions constant before they have properly adjusted themselves. This may result in serious error.

The conductivities of the materials as determined in this investigation agree fairly closely with those obtained by other investigators. The United States Bureau of Standards, for example, gives the following values for the conductivity of cork board:

Conductivity, B.t.u. per in. per deg. per sq. ft. per 24 hr.	7.4
Density of material, lb. per cu. ft.	11.3
Mean temperature of material, deg. fahr. (25 deg. cent.)	77.0

NEW FORD PLANT AT RIVER ROUGE

(*Continued from page 641*)

steam headers, both connections being on the same side of the boiler. From the saturated-steam headers the steam passes through the elements and is returned to the 12-in. superheated-steam header and discharged at the side opposite that at which it enters the saturated headers, thereby avoiding any possibility of short-circuiting and at the same time attaining correct steam distribution through all the elements.

Probably the most important and unique feature of the superheater is the location of the units. These are placed in the first pass of the boiler, protected by several rows of boiler tubes. The space for the location of the superheater units was selected in order to protect the elements from too high a temperature and at the same time provide for maintaining high superheat without overheating.

A feature in the unit or element design is the use of the forged return bend. These return bends are made on the ends of the units from the metal of the pipe itself by a special mechanical forging process without the use of electric or acetylene welding. The distribution of the metal in the return bends is such that there is an increased section in the bend at the point where the hottest gases impinge. The use of the forged return bend in the unit construction results in a continuous pipe, the bend itself being actually stronger than the body of the pipe. It also affords a sharp return without adding excessive pipe friction and facilitates the convenient and advantageous location of the superheater units.

Pulverized-Fuel Equipment

The boilers will be fired with a combination of pulverized coal and blast-furnace gas. A pulverizing plant of suitable capacity, using air separation mills, is being installed, and coal will be conveyed to the boilers from this plant by a series of screw conveyors.

Each boiler will be equipped with 12 "Lopulco" feeders and 4 "Lopulco" triplex burners, firing the coal vertically from the top. They will also be equipped with 8 gas burners for the purpose of injecting blast-furnace gas horizontally through the side, the gas flame and the pulverized-fuel flame so uniting at the proper point in the combustion chamber as to very greatly improve and increase the efficiency of the blast-furnace gas.

The possible capacity ratings when burning powdered coal will be extremely high, as the firing equipment is of such a capacity as to burn completely sufficient coal to produce 400 per cent rating continuously. It is probable that a high percentage of efficiency will be maintained throughout the whole cycle of operation, as the efficiency curve when pulverized fuel is properly handled is very flat from 50 per cent to 400 per cent of normal rating. The day operation of the boilers will be around 250 per cent of rated capacity.

A national convention of Italian engineers was held at Naples on May 20–25 under the auspices of the National Association of Italian Engineers. Among the topics discussed was that of Civic Activities of the Engineer.

There were present at the convention numerous government officials, delegations of Italian engineering associations and representative engineers from all sections of Italy.

The tenor of the addresses indicated a determination of the Italian engineers to assume "a leading position" in "technical and political" questions in Italy. It was emphasized by one of the principal speakers that to the engineers, who are by profession dedicated to the cultivation of the exact sciences, belongs an exalted position in all matters related to the general progress of humanity.

An incident of the convention was the reading by the chairman of a letter from the Federation of Italian Engineers, in which this organization announced that it had agreed voluntarily to its own dissolution, leaving the way clear for the National Association of Italian Engineers to engage in the furthering of civic activities of engineers in national questions.

Resolutions were adopted in which the desirability and importance of engineers taking an active interest in civic questions of national character were upheld, and reforms were suggested in regard to the policy followed by the Department of Public Works of Italy.

The New Fall Books

By Harrison W. Craver, Director Engineering Societies' Library

PUBLISHING is to a considerable extent a seasonal business, the busy period beginning with the first days of fall and extending through the months of winter. The present time is a favorable one, therefore, for surveying the probable literary output, as most of the important works that will appear have been arranged for.

In order to ascertain what may be expected, a number of the more important publishers were asked to indicate those of their proposed publications which they expected would appeal to the engineer, and a study of their replies was made.

One is immediately struck, upon looking over the list, with the general belief among publishers and authors that the questions upon which the public wishes enlightenment at present are economic rather than technological. Problems of management, of labor, of accounting and of selling account for a considerable part of the season's output of books. This is what would naturally be expected; the business field has been entirely neglected until recent times and the present demand for business books is extensive and increasing. Conditions prevailing since the war have brought matters of management to the front in a decisive manner.

Among general books for the executive we notice, first, Howard T. Wright's Organization as Applied to Industrial Problems (J. B. Lippincott Company). This, according to the publisher, is a concise general summary of the principles of organization, based on a varied business experience of twenty-five years. Other books are devoted to more specific problems, as Carle M. Bigelow's Management in the Woodworking Industry (*Industrial Management*); Walter N. Polakov's Mastering Power Production (*Industrial Management*), which discusses power-plant operation; and C. U. Carpenter's Increasing Production: Decreasing Costs (*Industrial Management*), which treats of ways and means for utilizing labor, machinery and floor space most efficiently. Two books intended primarily for college use may also be of interest, Horace Secrist's Readings and Problems in Statistical Methods (Macmillan) and O. B. Goldman's Financial Engineering (John Wiley and Sons). The first of these is intended to show students and executives, in a practical manner, how statistics may be used. The second is described as a textbook for consulting, managing and designing engineers and for students.

Among new books on accounting appears one entitled Accounts in Theory and Practice, by Prof. E. A. Saliers, of Yale University (McGraw-Hill), which attempts to emphasize principles more definitely than is customarily done. The Ronald Press Company offers a five-volume work entitled Business Accounting, prepared by a number of experts under the editorial supervision of Harold D. Greeley, the volume on cost accounting being written by D. C. Eggleston. The same publisher has issued also a book entitled Cost Accounting, Its Principles and Practice, by Gould L. Harris, of New York University, and J. P. Jordan, Vice-President of the C. E. Knoeppel Company. This book attempts, in addition to explaining the technique of cost accounting, to show the uses of cost-account data by executives to secure current control of the industry. G. Charter Harrison's Cost Accounting to Aid Production (*Industrial Management*) is also intended to aid the operating department as well as the treasurer, and so discusses cost accounts from an engineering viewpoint.

Technical advertising sees its first textbook in Advertising the Technical Product, by C. A. Sloan, Advertising Manager for the Hyatt Roller Bearing Company and J. D. Mooney, of the General Motors Company (McGraw-Hill), a book which discusses the special problems involved in preparing and placing the advertising of mechanical devices and similar manufactures. The McGraw-Hill Book Company will publish also Essentials of Advertising, by F. L. Blanchard, Editor of *The Fourth Estate*.

Two books on banking appear, intended for the business man rather than the banker. Chester A. Phillips' Bank Credit (Macmillan) explains commercial credit and discusses in detail the analysis of mercantile credit, the interpretation of credit statements and the evaluation of the different items. It should assist the merchant by its explanation of the principles that the bank applies in analyzing his statement. W. H. Kniffen's The Business Man and His Bank (McGraw-Hill) is intended to make the business man familiar with the work of a bank and to show him what he may expect the bank to do for him.

Commerce is represented by two books. The Elements of Marketing, by P. T. Cherington (Macmillan), is based on the author's experience in teaching the subject at Harvard University and is an attempt to formulate the principles underlying the transfer of merchandise from producer to consumer under modern conditions. The Century Company begins a new series on foreign trade with Robert E. Annin's Ocean Shipping: Elements of Practical Steamship Operation, a book dealing with the fundamentals of ship management and operation. Another book in the series that should prove useful is Packing for Export, by H. R. Moody, who was in charge of the packing and shipping of Government supplies overseas during the war.

Labor and labor problems have led to several books treating various phases of the question. Personnel Administration, by Ordway Tead and H. C. Metcalf (McGraw-Hill), is a systematic discussion from the management viewpoint. Daniel Bloomfield has written Labor Maintenance (Ronald), describing how harmony may be maintained between the management and the workers and giving practical Illustrations of accomplishment. Nathan W. Shefferman's Employment Methods (Ronald) discusses the functions of the employment department and describes modern methods of selecting and assigning men to obtain a stable labor force. Roy W. Kelly's Training Industrial Workers (Ronald) presents suggestions to be followed by industrial firms in training employees. The Macmillan Company announces John A. Ryan's Social Reconstruction, and The Church and Labor, by John A. Ryan and Joseph Husslein. The former book, compiled from lectures at Fordham University, outlines a comprehensive program, including a minimum wage, collective bargaining, coöperative societies, health insurance and labor participation in management. The second is an authoritative statement of the attitude and teaching of the Roman Catholic Church in relation to labor and society. The same firm also announces Sigmund Mendelsohn's Labor's Crisis, a discussion of some phases of the problem from the employer's point of view, which recommends improvement of housing and modified profit sharing.

Turning from general administrative matters to those more technical, the mechanical engineer finds two additions to the steadily growing library of handbooks. The Marine Engineers' Handbook (McGraw-Hill), edited by Lieut.-Com. F. W. Sterling, U. S. N., is the first American work of the kind and will undoubtedly prove welcome. J. D. Hoffman's Handbook for Heating and Ventilating Engineers (McGraw-Hill) is not new, but appears in a thoroughly revised and modernized form. Welding has been a much-discussed operation in recent days, and three new books are listed: Practical Electric Welding (Spon), by H. B. Swift; Gas and Electric Welding (American Technical Society), by George W. Cravens; and Spot and Arc Welding (Lippincott), by H. A. Horner. Two books deal with lubrication: One, a rewritten and enlarged edition of John R. Battle's Lubricating Engineers' Handbook, is now entitled Lubrication and Industrial Oils, and forms the first volume of a Handbook of Industrial and Oil Engineering to be published by the J. B. Lippincott Company. The other book is by T. C. Thomsen and is entitled Practice of Lubrication (McGraw). Prof. Franklin DeR. Furman, of Stevens Institute of Technology, announces a work entitled Cams: Elementary and Advanced (Wiley). Elements of Engineering Thermodynamics (Wiley) is the joint work of Director James A. Moyer, of the Massachusetts Department of University Extension, Prof. James P. Calderwood, of the Kansas State Agricultural College,

ENGINEERING INDEX (Continued)

Incidence Wires. Incidence Wires, Hilda P. Hudson. Aeronautical Jl., vol. 24, no. 117, Sept. 1920, pp. 505–516, 3 figs. Inclusion of incidence wires in strength calculations by method of strain energy. Little difference is found in normal flight conditions, but inclusion shows large changes in wing loads in nose diving and in center section loads with broken flying wire.

Lacoin-Damblanc "Alerion." The Great Problem of Stationary Flying (Le grand problème du vol sans vitesse), Ernest Archdeacon. Aérophile, vol. 28, nos. 11–12, June 1–15, 1920, pp. 168–172, 3 figs. Description of the "Alerion," an aeroplane invented by MM. Lacoin and Damblanc, which is said to be capable of rising directly vertically and supporting itself in the air. Machine carries two four-bladed propellers which rotate in horizontal planes for vertical flight, and at inclined angle for advancing forward.

Military, German. The Development of German Military Aircraft During the War (Die Entwicklung deutscher Heeresflugzeuge im Kriege), W. Hoff. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 27 and 28, July 3 and 10, 1920, pp. 493–499 and 523–528, 38 figs. Describes most important exponents of different construction types with details of various construction parts. Data on number of German aeroplanes at the front and successful flights of the different types. Address delivered before Sci. Soc. for Aviation in Hamburg.

Olympia Show. The International Aero Exhibition —I. Engr., vol. 130, no. 3368, July 16, 1920, pp. 52–54 and p. 62, 17 figs. partly on supp. plate. Models exhibited.

Pacific Hawk. The Pacific Hawk Commercial Airplane. Aviation, vol. 9, no. 2, Aug. 15, 1920, pp. 47–48, 2 figs. Data: Overall length, 32 ft.; overall height, 10 ft. 8 in.; span, 52 ft.; total weight, loaded, 3950 lb.; maximum speed, 82 m.p.h.; climb in 10 minutes, 4100 ft.

Passenger. The Airco 18 Aeroplane. Eng., vol. 110, no. 2851, Aug. 20, 1920, pp. 238–240, 27 figs. partly on supp. plate. Designed by Aircraft Manufacturing Co., Ltd., Hendon, England, for passenger and goods carrying service operated by Aircraft Transport and Travel, Ltd., between London and Paris and London and Amsterdam. Machine is capable of carrying 8 passengers in addition to pilot and from 200 lb. to 500 lb. of baggage. It is fitted with 450-hp. Napier engine which gives 500 hp. at 2200 r.p.m. and drives 2-bladed propeller through gearing at 1400 r.p.m.

Sablatnig. The Sablatnig Traffic Aeroplane (Das Sablatnig-Verkehrsflugzeug), Werner v. Langsdorff. Motorwagen. vol. 23, no. 18, June 30, 1920, pp. 326–327, 3 figs. Details of aerial limousine, carrying four passengers besides pilot and observer, designed by Sablatnig and employed for aerial traffic between Berlin-Warnemünde-Copenhagen. Specifications: Engine, 200 hp., 6-cyl. Benz; construction, mainly wood; weight empty, 1335 kg. load, 770 kg.; fuel consumption, 75 liters gasoline per hr.; speed, 120 to 140 km. per hr.

Slow-Speed. The Slow-Speed Airplane, F. H. Norton. Aviation, vol. 9, no. 3, Sept. 1, 1920, pp. 80–82, 8 figs. Accounts of model experiments conducted in order to determine amount of lift and deflection of slipstream for machine having large portion of wings in slipstream of tractor screws and using trailing-edge flaps to deflect air downward.

Specifications, U. S. Air Service. Specification for Gasoline Level Gages, no. 27,009-C, Feb. 10, 1920; Specification for Aircraft Name Plates, no. 40,017, June 1, 1920; Specification for Airplane Parachutes and Parachute Equipment, no. 40,009-B, June 20, 1920; Specification for Application of Fabric to Aerofoil Surfaces, no. 24,108-C, Jan. 25, 1920; Specification for Bakelized Fabric Propellers, no. 29,514, Apr. 1, 1920; Specification for Reverse Current Relays, no. 27,105, Feb. 15, 1920; Specification for Silk Thread for Use in Airplane Construction, no. 16,015-A, May 10, 1920; Specification for Standard Valves for Oxygen Supply Tanks, no. 27,082-A, May 1, 1920; Specification for Elastic Cord for Shock Absorbers, no. 26,501-E, Apr. 20, 1920; Specification for Waterproof Fabric Covers for Airplane Engines, Cockpits and Propellers, no. 26,751-A, Jan. 20, 1920; Specification for Air and Gasoline Pressure Gages, no. 27,080-A, Dec. 16, 1919; Specification for Power and Lighting Cables for Airplanes, no. 27,074-A, Mar. 10, 1920; Specification for High Manganese Steel Spring Wire, no. 10,292, May 20, 1920; Specification for Airplane Enamels, no. 14,028, Dec. 15, 1919.

Speed, Measurement of. Note on Measurement of Speed of Airplanes, J. G. Coffin. Aviation, vol. 9, no. 2, Aug. 15, 1920, pp. 54–55, 6 figs. Graphical method for computation and interpretation of results obtained in trials.

Timber Splices. An Investigation into Various Types of Timber Splices for Aeroplane Construction, G. W. C. Kaye and J. Hudson Davies. Aeronautical Jl., vol. 24. no. 117, Sept. 1920, pp. 517–525, 26 figs. Tests conducted by Aeronautical Inspection Department, Royal Air Force. "Straight" splices with contact face, either flat or alternatively serrated and meshed are recommended as best form of scarf for splicing timber which is to be subjected to bending movement.

Torpedoplanes. German Torpedoplanes (Deutsche Torpedoflugzeuge), Werner v. Langsdorff. Schiffbau, vol. 21, no. 32, June 30, 1920, pp. 873–874. Account of types used successfully during war, designed by K. Roesner of the Gotha car shops, developed from the double-engine giant aeroplane Gotha, which is also constructed as a seaplane. Also used as observation planes and for transportation of troops in rapid occupation of small islands, etc.

Wings. Preliminary Choice of a Wing Section, W. F. Gerhardt, B. C. Boulton and L. V. Kerber. Aerial Age, vol. 11, no. 25, Aug. 30, 1920, pp. 839–841 and 849. Analytical tests are suggested for preliminary evaluation of aerofoils best adapted for given conditions of aeroplane design.

The Alula High-Lift Wing. Aerial Age, vol. 11, no. 25, Aug. 30, 1920, pp. 836–838, 3 figs. Data on wing recently developed in England.

Wisenant. The Wisenant Longitudinal Aeroplane, M. A. Spicer. Aerial Age, vol. 11, no. 24, Aug. 23, 1920, pp. 804–805, 5 figs. Main panels are placed parallel with fuselage instead of at right angles as in all other heavier-than-air machines. Twin propellers, driven by single engine through shaft drive and small panels attached to lower part of fuselage directly back of propellers, are also novel feature

[See also FLYING BOATS; SEAPLANES.]

AIR PUMPS

Radojet. The Radojet Air Pump, M. C. Stuart and Arthur H. Senner. Jl. Am. Soc. Naval Engrs., vol. 32, no. 3, Aug. 1920, pp. 437–471, 32 figs. partly on 9 supp. plates. Results of tests made at U. S. Naval Eng. Experiment Station, Annapolis, Md. on two Radojet air pumps manufactured by C. H. Wheeler Manufacturing Co.

AIRCRAFT CONSTRUCTION MATERIALS

McCabe Sleeve. The McCabe Sleeve, I. E. McCabe. Aviation, vol. 9, no. 2, Aug. 15, 1920, pp. 60–62, 2 figs. McCabe sleeve is a wire-rope fastener applied by use of mechanical means only and has been developed chiefly for use on aircraft. Method of forming it is explained.

[See also WOOD, Moisture-Resistant Finishes.]

AIRSHIPS

Determination of Resistance. Determination of the Resistance of Airship Models, R. H. Smith. Aviation, vol. 9, no. 2, Aug. 15, 1920, pp. 44–47. Comparative value of Eiffel and bell-crank aerodynamic balances.

Non-Rigid. Model Test for Strength and Deformation of Non-Rigid Airship Hulls, J. C. Hunsaker. Aviation, vol. 9, no. 2, Aug. 15, 1920, pp. 53–54, 3 figs. Aircraft Technical Note, Bureau of Construction and Repair, Navy Dept.

ALCOHOL

Synthetic. Synthesis of Alcohol by Loisy Process (L'alcool de synthèse par le procédé de Loisy). Journal des Usines à Gaz, vol. 44, no. 13, July 5, 1920, pp. 193–195. Reaction consists of absorption of ethylene by concentrated sulphuric acid with formation of sulphovinic acid, saponification of this by water, with regeneration of dilute sulphuric acid and production of alcohol.

ALLOY STEELS

Heat Treatments for. Some Commercial Heat Treatments for Alloy Steels, A. H. Miller. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 506–508, 11 figs. Deals with heat treatment of alloy steels used for structural purposes, specially of nickel and nickel-chrome steel, and describes series of tests which were conducted to determine effect of various heat treatments on samples of same chemical composition, results being illustrated by series of photomicrographs showing effect of different adjustments of temperature, time and rate of cooling of heat treatment.

Impact Tensile Tests. Impact Tensile Tests with Alloy Steels (Schlagzugversuche mit Sonderstählen), A. Gessner. Stahl u. Eisen, vol. 40, no. 23, June 10, 1920, pp. 781–783, 1 fig. Results of impact tests show that alloy steels of pronounced tenacity, even up to a tensile strength of 100 kg. per sq. mm. and in spite of the extremely short duration of the impact stress—0.003 to 0.005 sec. —give higher values for elongation, construction and resilience than those with steady stress in the static tests.

Manufacture. The Production of Tool Steel, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 42–46, 8 figs. Processes employed in steel mill of Ludlum Steel Co., Watervliet, N. Y., which is engaged exclusively in manufacture of tool and special alloy steels.

ALLOYS

Developments. Alloys of the Past and Present, Colin G. Fink. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 471–473, 2 figs. Review of recent developments in production of pure metals, ferroalloys, bronzes and brasses and of increasing uses for less common metals and their alloys. Research suggestions for production of special alloys.

Electrical Melting. Electrical Melting of Alloys—XIII, H. W. Gillett. Foundry, vol. 48, no. 354, Sept. 1, 1920, pp. 693–695. Future of electric furnace in alloy industry is considered as a whole and in reference to different types of furnaces and possibilities of each class.

ALUMINUM

Nickel Plating. Nickel Plating of Aluminum (Nickelage de l'aluminium), Léon Guillet and M. Gasnier. Revue de Métallurgie, vol. 17, no. 5, May 1920, pp. 351–359, 10 figs. Results obtained by first roughening surface of aluminum with sand blast, also with preliminary copper plating before plating with nickel.

Wire Joints. Investigations of the Size and Durability of Wire Joints with Special Regard to Aluminum (Untersuchungen über die Grösse und Beständigkeit von Kontaktverbindungen unter besonderer Berücksichtigung des Aluminums), Rudolf Richter. Elektrotechnische Zeitschrift, vol. 41, nos. 18, 19, 20, 21, 22 and 23, May 6, 13, 20, 27, June 10, 1920, pp. 345–351, 367–370, 386–392, 409–413, 433–435 and 448–452, 19 figs. Results of investigations extending over $3^{1}/_{2}$ years of 421 screwed, riveted, soldered and twisted joints of aluminum and other metallic wires showed that in every respect satisfactory screw and solder joints between aluminum and other metals are possible; twisted and riveted joints with aluminum are unreliable; position of metals to be joined in the electric contact series has no important bearing on size and durability of the joints.

ALUMINUM ALLOYS

Aluminum-Copper. Some Theoretical Principles of Alloying, Robert J. Anderson. Chem. & Metallurgical Eng., vol. 23, no. 8, Aug. 25, 1920, pp. 317–320, 6 figs. Discussion of possible applications of such general concepts as may be drawn from equilibrium diagram, heat of alloy formation, thermit reaction, diffusion and solution to problems connected with production of aluminum-copper alloys in the foundry.

Industrial Uses. Alloyed Aluminum as an Engineering Material, G. M. Rollason. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 495–500, 11 figs. Traces improvement in development of commercial alloys, presenting in connection therewith photomicrographs on alloys commonly used, discusses subject of casting of aluminum as well as methods employed in both cold and hot rolling of metal, and visualizes possible future uses of aluminum and its various alloys.

Uses in Automotive Industry. Aluminum Alloys, Zay Jeffries. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 295–299 and p. 305, 14 figs. Effect of aluminum alloying on its physical properties, and uses of aluminum alloys in automotive industry.

[See also DURALUMIN.]

AMMONIA

Synthetic. The Direct Synthetic Ammonia Process, R. S. Tour. Jl. Indus. & Eng. Chem., vol. 12, no. 9, Sept. 1920, pp. 844–852, 7 figs. General outline of process as developed by Fritz Haber, of Karlsruhe, Germany, and C. Bosch, of Badische Anilin Fabrik.

APPRENTICES, TRAINING OF

Ford Motor Co. Training 300 Apprentice Die-Makers with One Instructor, Norman G. Shidle. Automotive Industries, vol. 43, no. 10, Sept. 2, 1920, pp. 472–475, 6 figs. Course given at plant of Ford Motor Co.

AQUEDUCTS

Reinforced-Concrete. The Construction of the Pouilles Aqueduct (L'achèvement de l'aqueduc des Pouilles). Génie Civil, vol. 77, no. 6, Aug. 7, 1920, pp. 105–109, 13 figs. Details of reinforced-concrete siphons. (Concluded.)

AUTOMOBILE ENGINES

Aluminum in. The Status of Aluminum in the Automobile Engine, J. Edward Schipper. Automotive Industries, vol. 43, no. 10, Sept. 2, 1920, pp. 468–470, 6 figs. After five years of development, engineers are unable to agree as to future of lighter metal. Most of those who are using it for pistons are firm believers, but there seems to be limit in size. It is popular for crankcase housings, but has not been adaptable for axle manufacture.

Connecting Rods. Seventy-Five Operations Give Accuracy in Connecting Rod Production, J. Edward Schipper. Automotive Industries, vol. 43, no. 11, Sept. 9, 1920, pp. 522–526, 14 figs. Production methods used on Marmon cars.

Liberty. A Specially Designed Engine for the Liberty Car, P. M. Heldt. Automotive Industries, vol. 43, no. 12, Sept. 16, 1920, pp. 558–561, 4 figs. Engine is of a 6-cylinder block type, $3^{1}/_{8}$ in. bore and 5 in. stroke. Cylinder heads are cast in pairs and three identical head castings are then bolted to same cylinder block.

Off-Set. The Off-Set Motor (Les Moteurs désaxés), H. Petit. Vie Automobile, vol. 16, no. 711, Aug. 10, 1920, pp. 293–295, 9 figs. Graphs showing comparative lateral pressures in cylinder for ordinary type and off-set type. In off-set motor center of crank does not lie in projection of axis of cylinder.

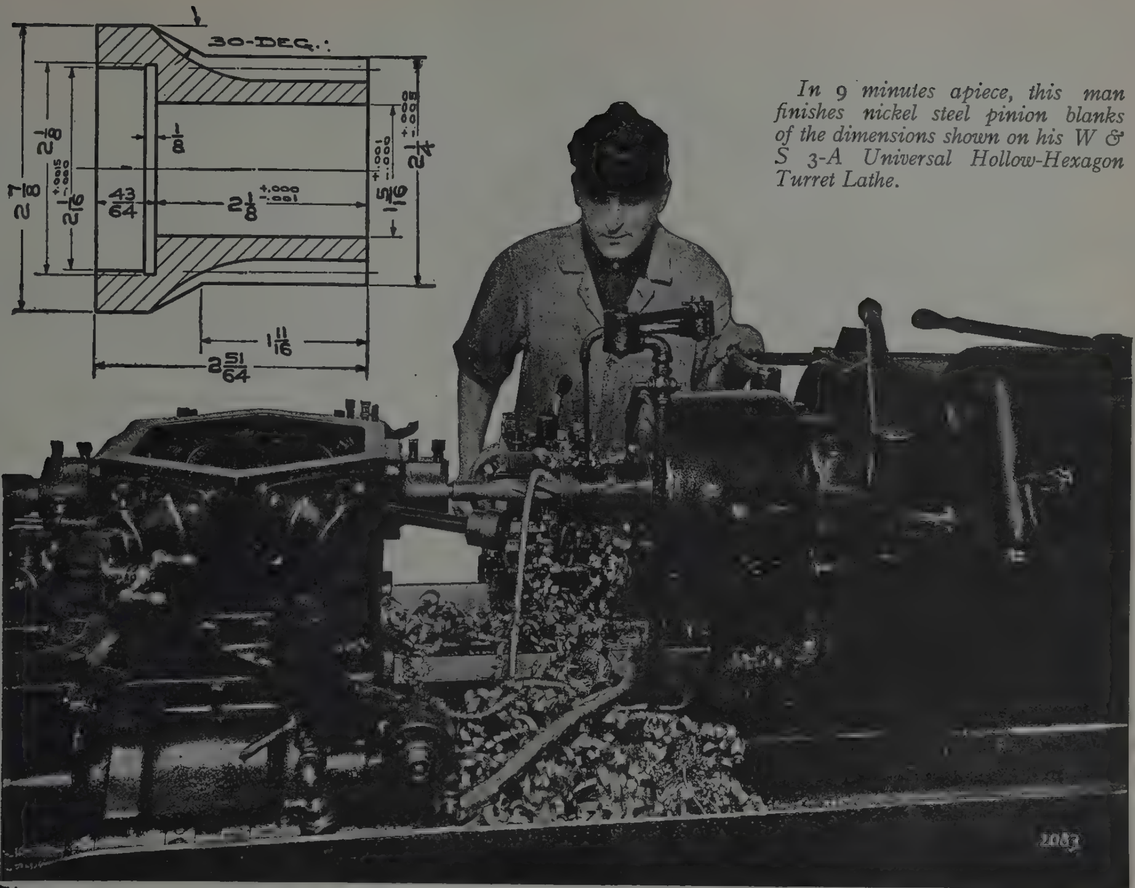
Paige. Paige Announces New Engine for Big Six Model, J. Edward Schipper. Automotive Industries, vol. 43, no. 11, Sept. 9, 1920, pp. 507–509, 6 figs. L-head type, $3^{3}/_{4}$ in. x 5 in., six cylinder, block-cast unit with separate cylinder head, aluminum crankcase and pressed steel oil pan.

Pistons. Cast-Iron and Aluminum Pistons, Fred H. Colvin. Am. Mach., vol. 53, no. 9, Aug. 26, 1920, pp. 416–421, 18 figs. Methods used by builders of Studebaker and Oakland cars in machining their pistons.

New Type Aluminum Piston in Cole. Motor Age, vol. 38, no. 9, Aug. 26, 1920, pp. 13 and 29. It is said that an aluminum piston that will not "slap" or stick has been developed by Cole engineers. Such piston is claimed to have worked satisfactorily in trials at Indianapolis motor speedway under A. A. A. suction. No details of piston are given.

Radiators. Special Methods for Making Radiators, Fred H. Colvin. Am. Mach., vol. 53, no. 4, July 22, 1920, pp. 176–177, 5 figs. Methods of assembling, soldering and testing radiators.

Sleeve-Valve. A New Sleeve-Valve Motor: The Serex. Auto, vol. 25, no. 35, Aug. 26, 1920, pp. 896–897, 3 figs. Original features are that main


30-DEG.
$2\frac{7}{8}$
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$2\frac{1}{4}$ +.000 −.005
$1\frac{11}{16}$
$2\frac{51}{64}$
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ENGINEERING INDEX (Continued)

inlet and exhaust ports are differently located from either Argyll or Knight, that it possesses separate fuel admission, and that although it is a four-stroke motor, piston coöperates with sleeve to determine opening and closing of inlet, exhaust and fuel admission ports.

Starter Ring Gear. Flywheel Starter Ring Gears, Fred H. Colvin. Am. Mach., vol. 53, no, 11, Sept. 9, 1920, pp. 513–515, 1 fig. Manufacture by Ford Motor Co. of steel ring gear that bolts to flywheel and which obviates broken teeth and undue wear.

[See also IGNITION; RESEARCH, Industrial Laboratories.]

AUTOMOBILE FUELS

Combustion of, Regulation. Combustion of Fuels in Internal-Combustion Engines, C. F. Kettering. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 224–227. Regulating combustion by addition of chemicals to fuels. It is visualized that if, for example, automotive industry could get chemical industry to increase coal-tar production of country, enabling aniline to be sold at $2 per gal., and automotive industry would use 1 per cent, then compression of automobile engines could be raised to 100 lb. and thus efficiency of normal running almost doubled.

Germany. German Government Will Create Standard Motor Fuel, Benno R. Dierfeld. Automotive Industries, vol. 43, no. 11, Sept. 9, 1920, pp. 501–506. Results of scientific reference on fuel studies of German cars carried on by German chemists and engineers. As outgrowth of these experiments German Government has decided to create standard fuel, which is to consist of mixture of very heavy hydrocarbons with such lighter products as gasoline and benzol.

[See also GASOLINE.]

AUTOMOBILES

Assembling. Motor Car Assembling at Hudson Plant. Iron Age, vol. 105, no. 18, April 29, 1920, pp. 1219–1221, 3 figs. Parts enter building separately through doors at convenient points and are assembled, painted and dried on nine parallel conveyor lines.

Automobile Boat. The Miller-Metcalf "Amphyglider." Autocar, vol. 45, no. 1297, Aug. 28, 1920, pp. 373–374, 4 figs. Automobile boat driven by air propeller.

Front Axles, Machining of. Machining Front Axles, Fred H. Colvin. Am. Mach., vol. 53, no. 12, Sept. 16, 1920, pp. 553–555, 8 figs. Operations applied by Columbia Axle Co., Cleveland, Ohio.

Lafayette. Eight-Cylinder Automobile Has Light Weight Feature, J. E. Schipper. Automotive Industries, vol. 43, no. 8, Aug. 19, 1920, pp. 356–362, 7 figs. Total weight is 2574 lb., engine is $3^1/_4$ x $5^1/_4$ in., cast in two blocks of four, with detachable heads. Blocks are set at angle of 90 deg. and valves which are located in V are set at angle of 90 deg. to axis of cylinder. Crankshaft is $2^1/_4$ in. in diameter, of five-bearing type and weighs $30^1/_2$ lb. Springs are semi-elliptic, front being 42 x $2^1/_4$ in. and rear 60 x $2^1/_2$ in.

Lincoln. Lincoln Car Has an Eight-Cylinder, 60 Deg. Vee Engine, J. Edward Schipper. Automotive Industries, vol. 43, no. 12, Sept. 16, 1920, pp. 554–557, 10 figs. This innovation permits use of smaller hood and gives radial rotating force of constant magnitude instead of horizontal reciprocating force.

Wheel Wabbling. Cause and Cure of Front Wheel Wabbling, A. Ludlow Clayden. Automotive Industries, vol. 43, no. 9, Aug. 26, 1920, pp. 411–414, 4 figs. Account of experiments made with a view to determine best method of eliminating front-wheel wabbling.

[See also CARBURETORS; SPARK PLUGS; TIRES.]

AVIATION

Altitude Records. The Valuation of Altitude Records (Zur Wertung von Höhenrekorden), E. Everling. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 9, May 15, 1920, pp. 121–123. States that altitude records should not represent actual distance from earth surface or sea level or a measure of the air pressure, but should represent measure of the density of air. A simple relation between density and altitude is suggested.

B

BALLOON FABRICS

Fireproofing of. The Fireproofing of Sacking, Tent Linen and Balloon Materials (Die Imprägnierung von Sackstoffen, Zeltleinen und Ballonstoffen gegen Feuer), Willy Hacker. Kunstoffe, vol. 10, no. 6, Mar. 2, 1920, pp. 61–64. Most effective media for rendering textures fireproof are said to be ammonium sulphate and ammonium phosphate. Describes various foreign and domestic patents.

BARGES

Reinforced-Concrete. Construction of Reinforced-Concrete Ocean-Going Barges (La construction des chalands de mer en béton armé), H. deLauriston. Génie Civil, vol. 77, no. 8, Aug. 21, 1920, pp. 145–148, 8 figs. Lezard, first of set being constructed for coal traffic between England and France. Dimensions: Length, 50 m.; width, 10 m.; draught, 5.25 m.; displacement, 1100 tons.

BATHHOUSES

Vienna. The Machinery and Hydraulic Installations in the New Diana Bath in Vienna (Die Maschinen- und Badetechnischen Anlagen in neuen "Dianabad" in Wien), Hermann F. Parmet. Gesundheits-Ingenieur, vol. 43, nos. 19 and 22, May 8 and 29, 1920, pp. 217–224 and 256–260, 12 figs. Description of palatial bath erected during war and said to be unrivaled in every respect. Details of power plant, water filtration plant for swimming pool, laundry plant, ventilation and heating plants, etc.

BATTERIES

Standard Cells. A New Form of Standard Cell, C. J. Rodman and Thos. Spooner. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 8, pp. 49–63, 6 figs. Cadmium cell with usual ingredients but having container of hard glass. Instead of common H-type, compact concentric arrangement is employed.

BEAMS

Continuous. Calculation of Continuous Beam Supported on Elastic Columns (Calcul des poutres continues sur piliers élastiques), J.-P.-L. Busset-Schiller. Bulletin technique de la Suisse romande, vol. 46, no. 16, Aug. 7, 1920, pp. 185–187, 6 figs. Technical study. (To be continued.)

Reinforced-Concrete. Reinforcement for Diagonal Tension, W. S. Thomson, W. A. Slater, Mr. Thompson, Sanford E. Thompson and Duff A. Abrams. Concrete, vol. 17, no. 2, Aug. 1920, pp. 43–46, 2 figs. Discussion of paper by Edward Godfrey published in July issue of Concrete. Mr. Godfrey criticized employment of vertical stirrups as diagonal tension reinforcement for concrete beams. Present writers argue in favor of such stirrups and also comment on Mr. Godfrey's suggested ideal method of reinforcing for diagonal tension.

BEARINGS

Self-Lubricating. A New Self-Lubricating Material. Textile World Jl., vol. 58, no. 11, Sept. 11, 1920, p. 41. "Cellugraph" bearings and bushings made of hard wood, usually maple, impregnated by special chemical process which is claimed to form basis of practically inexhaustible supply of lubricant.

BEARINGS, BALL

Three-Area Contact. Manufacturing Three-Area Contact Ball Bearings. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 34–36, 16 figs. Description of manufacturing, inspection and assembling methods used in shops of Federal Bearings Co., Inc., Poughkeepsie, N. Y. in producing three-area ball bearings. Second of two articles.

BELTING

Specifications. Notes on Operation and Care of Leather Belting, H. T. Clawson. Belting and Transmission, vol. 17, no. 4, Aug. 20, 1920, pp. 31–34, 5 figs. Navy Department specifications. Rules for calculation.

BLAST-FURNACE GAS

Burners. New Burner for Blast-Furnace Gas, Donald N. Watkins. Blast Furnace and Steel Plant, vol. 8, no. 9, Sept. 1920, pp. 499–505, 14 figs. Steinbart burner as used in blast furnaces at Lorain Works of National Tube Co. Automatically regulates air for burner.

BLAST FURNACES

Design. Design of Shaft Base and Framework for Blast Furnaces (Bauart der Schachtträger und des Gerüstes für Hochöfen), B. Cellar. Stahl u. Eisen, vol. 40, no. 29, July 22, 1920, pp. 965–969, 6 figs. Details of older and newer types, and description of a new construction of shaft base by use of which from tapping platform a free view and undisturbed operation can be obtained as well as easy access to all parts of boshes and furnace shaft. Gives load assumptions and steel stresses in general use for blast-furnace frameworks.

Slag. Experiments with Blast-Furnace Slag (Versuche mit Hochofenschlacke), H. Burchartz. Stahl u. Eisen, vol. 40, no. 24, June 17, 1920, pp. 814–819. Tables showing results of tests of slag to determine weight per unit volume, specific gravity and density; and of slag and quarry stone samples stored in open air, per unit volume, which showed that weight even after five years' open-air storage, did not vary, and that the slag suffered no physical or chemical changes.

BLASTING

Compressed-Air. Blasting Granite with Compressed Air, Oliver Bowles. Reports of Investigations, Bur. of Mines, serial no. 2154, Aug. 1920, 3 pp. Application as substitute for explosives for breaking rock in granite quarries in Lithonia, Ga.

BLIND

Employment of. Cleveland Shops Open to Blind Workers, Eva B. Palmer. Iron Age, vol. 106, no. 10, Sept. 2, 1920, pp. 569–572, 4 figs. Sixty-nine manufacturing operations now performed in that city by sightless, principally in metal-working industries. Workers prove efficient.

BLOWERS

Turbo, Single-Stage. Single-Stage Turbo-Blower Operating Normally at 22,000 R.P.M. Power, vol. 52, no. 9, Aug. 31, 1920, pp. 327–328, 4 figs. Capable of compressing in single stage 4000 cu. ft. of free air per min. to 21 lb. per sq. in. with rotor running at top speed of 1400 ft. per sec. Turbine develops normally 300 hp. and weighs 6.7 lb. per horsepower.

BOILER FEEDWATER

Heating. Feed Heating for Land Power Stations—II and III, K. Baumann. Engr., vol. 130, nos. 3372 and 3373, Aug. 13 and 20, 1920, pp. 150–152 and 127–130, 5 figs. Fundamental principles governing economy of power stations. Comparison of heat consumption of prime mover with various methods of heating feedwater by steam.

BOILER FIRING

Soot Abatement. Soot and Its Abatement by the Use of Salt, B. S. Murphy. Power, vol. 52, no. 9, Aug. 31, 1920, pp. 322–326. Method of treatment and results from using common salt as obtained from actual experience in large railway power plant.

Woodshop Waste. Woodshop Waste Runs Power Plant. Power Plant Eng., vol. 24, no. 17, Sept. 1, 1920, pp. 821–827, 9 figs. Four boilers at new works of General Motors Co. equipped for burning factory refuse.

BOILER OPERATION

Combustion Control. Indicators for Carbon Dioxide and Oxygen in Air and Flue Gas, L. H. Milligan, D. O. Crites and W. S. Wilson. Dept. of Interior, Bur. of Mines, technical paper 238, 1920, 23 pp., 12 figs. Instruments designed in chemical research laboratory at Pittsburgh experiment station of Bureau of Mines.

BOILERS

Electrically Heated. Electric Heating for Industrial Purposes (Elektrische Heizung in der Industrie), H. Immerschitt. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 18, 19, 20 and 21, Apr. 30, May 7, 14 and 21, 1920, pp. 129–131, 139–141, 147–149 and 155–157, 29 figs. Notes on hot water and steam generators with electrode heating. Includes abstracts of paper by Rutgers in Le Génie Civil (no. 9, 1919) on employment of electric heating in industrial works and from paper by E. Höhn in Schweiz. Bauzeitung (nos. 19, 20 and 21, 1919) on electrically heated steam boilers and heat-storage tanks.

The Growing Importance of the Electric Heating of Steam Boilers, etc. (Die erhöhte Bedeutung der elektrischen Beheizung von Dampfkesseln u. dgl.), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 37, nos. 80 and 81, May 19 and 20, 1920, pp. 351–352 and 355, 3 figs. Two heating methods for electrically heated boilers are described: namely, resistance heating, in which the heat originating in the flow of electric current through a conductor is used for heating purposes; and electrode heating, in which current flowing between electrodes heats the water. Various systems according to both methods are described as well as electrically heated boilers for heat storage.

Heat Transfer in Flues. Heat Transfer in Flues, Lawford H. Fry. Eng., vol. 110, no. 2852, Aug. 27, 1920, pp. 265–268, 5 figs. Formulæ are derived and their experimental and mathematical bases explained.

Horizontally Baffled. Horizontally Baffled Boilers. Power Plant Eng., vol. 24, no. 17, Sept. 1, 1920, pp. 834–836, 4 figs. Describes series of four tests conducted on one unit of installation to ascertain whether arrangement of horizontal baffling suitable for attaining high capacities would prejudice efficiencies obtainable at lower ratings. It was found that arrangement of baffling which is especially suitable for obtaining maximum capacities does not affect adversely efficiencies obtained at lower ratings.

Inspection. Value of Steam Boiler Inspection at Mines, H. M. Motherwell. Coal Industry, vol. 3, no. 9, Sept. 1920, pp. 437–440. Statistics are included which show that one boiler in seven is defective, one in three has scale, and one in seventy is dangerously affected.

[See also WELDING, Boiler Repairs.]

BORING MACHINES

Crankcase Bearings. A Machine for Boring Line Bearings, J. V. Hunter. Am. Mach., vol. 53, no. 4, July 22, 1920, pp. 162–163, 4 figs. Machine used for boring and reaming bearings of automobile crankcase.

BRASS

Special. Special Brass (Les laitons speciaux), Léon Guillet. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, vol. 73, nos. 1, 2, 3, Jan.-March 1920, pp. 154–182, 25 figs. partly on supp. plate. Special brass is defined to be any copper-zinc alloy with which any other metal or other metals have been incorporated. Results of experimental determination of properties of such alloys are given, and a general theory of combinations of binary alloys with third metal is developed.

[See also COPPER, Extruded Rods.]

BRICK

Belgian, Tests of. Note on the Manufacture of Brick in Belgium (Note sur la fabrication des briques du pays), L. Bonnet. Annales des Travaux Publics de Belgique, vol. 21, no. 3, June 1920, pp. 353–390, 7 figs. Tests on brick manufactured in Belgium, also on some made in Holland and on "Klinkaert" bricks. Tests were carried out at the State laboratory at Malines.

Standard-Size. Why There Should be a Standard Size for Common Brick, William Carver. Brick & Clay Rec., vol. 56, no. 12, June 1, 1920, pp. 1105–1106. Paper before Common Brick Manufacturers' Assn. at meeting in Feb. when Assn. adopted $2^1/_4$ x $3^3/_4$ x 8 in. as standard-size brick.

BRIDGES, CONCRETE

See BRIDGES, RAILWAY, Concrete.

SHOWS WHERE COST OF COAL INCREASED

United Mine Workers' Economist Issues

STRIKING MINERS THREATEN VIOLENCE

Insurgents Said to Plan Reign of Terror in Anthracite Field.

HOMES ... DYNAMITED

NEW COAL STRIKE HALTS MANY MINES

W YORK TIMES, S

UTILITY COAL PERIL STILL MENACES CITY

Told of Haz- Day Supply eserve.

NATURAL GAS FAILS FAST

Wyer Tells Conference Supply Last Only

N EXPORTS

DEN SAYS COAL CRISIS IS APPALLING

tatement at Chicago, he Situation Men- he Country.

90 PER CENT. OF MINES IN ILLINOIS ARE CLOSED

Situation Is Becoming Critical and Operators Assert Government Must Get Men Back.

RM CARS THE CRUX OF COAL EMERGENCY

n Fuel Men Tell Inquiry y Carrying Facility ould Be Utilized.

TO DEMAND COAL GOUGING END

Conference of Operators Discuss Prices, Wages and Production.

GENERAL HINES RESI

What are You doing about it?

The Fuel Crisis is a most real, live issue. Not only is there a Coal Shortage amounting almost to Famine, but our supplies of Oil and Natural Gas both fall far short of the rapidly growing demand.

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ENGINEERING INDEX (Continued)

BRIDGES, LIFT

Bascule. Chicago Bascule Bridge—Design and Operating Features, Hugh E. Young. Eng. News-Rec., vol. 85, no. 11, Sept. 9, 1920, pp. 508–514, 10 figs. Four-truss duplex construction of double-deck bridge. Emergency grip brakes. Interlocked control of gates, locks, safety devices and machinery.

BRIDGES, RAILWAY

Concrete. The Butin Bridge Over the Rhône near Geneva (Le pont Butin sur le Rhône près Genève), M. Brémond. Bulletin technique de la Suisse romande, vol. 46, no. 14, July 10, 1920, pp. 157–161, 7 figs. partly on supp. plate. Reinforced-concrete structure.

Lift-Span. Novel Falsework Method Used on New Haven Bridge. Ry. Age, vol. 69, no. 11, Sept. 10, 1920, pp. 433–438, 11 figs. Bridge had to be erected in such a manner as to maintain an open channel at all times and to permit opening and closing of old draw span.

BRIDGES, STEEL

Alloy Steels for. Economical Use of Alloy Steel for Bridge Construction (De l'emploi économique des alliages d'acier dans la construction des ponts), J.-A.-L. Waddell. Comptes rendus de Séances de l'Académie des Sciences, vol. 171, no. 2, July 12, 1920, pp. 80–83. It is prescribed that if R is ratio of prices per unit of two steels considered, and R inverse ratio of their elastic limits, then it is economical to use the higher priced when RR^1 is less than 1. Examples are worked out.

Testing. New Regulations of the French Ministry of Public Works for the Calculation and Testing of Metallic Bridges. Bul. Int. Ry. Assn., vol. 2, no. 7, July 1920, pp. 434–458, 6 figs. Regulations are applicable to (1) underbridges carrying normal-gage lines of rails, (2) underbridges carrying meter-gage lines of rails, (3) overbridges carrying roads, and (4) canal bridges. Translated from Annales des Ponts et Chaussées.

BRIDGES, SUSPENSION

New York-New Jersey. The Proposed Victory Bridge Over the Hudson Between New York City and Weehawken, Robert Imlay. Architectural Rec., vol. 48, no. 3, Sept. 1920, pp. 219–223, 4 figs. Suggested design.

BUILDING CONSTRUCTION

Costs. When Will Building Costs be Lower? Brick & Clay Rec., vol. 57, no. 3, Aug. 10, 1920, pp. 218–219, 2 figs. Study made by Fuller Indus. Eng. Corp. It is believed that no great financial depression will ultimately affect cost of materials and labor but that decline in building costs will be small and slow to follow downward trend of other commodities because of great demand of building space, which will not be changed, until shortage due to war has been eliminated.

Porous Concrete Slabs. New Material Used in Manufacturing Building at Newark, N. J. Am. Architect, vol. 118, no. 2331, Aug. 25, 1920, pp. 255–260, 15 figs. Porous-concrete slabs. Mechanically produced pellets of neutral wax-like material are added to concrete. After slab is formed pellets are removed by application of heat.

Rod Pisé Construction. The Lewandowsky Rod Pisé Construction (Der Stabpiseebau nach der Bauart Lewandowsky). Zentralblatt der Bauverwaltung, vol. 40, no. 26, Mar. 31, 1920, pp. 148–150, 4 figs. Describes building method using compressed clay and pisé which was tried out in construction of a group of small dwellings in Hildesheim and said to possess good insulating qualities and to effect a considerable saving in cost over brick construction.

Statistics of New Construction throughout United States. Public Rebels Against Closed Shop System. Iron Trade Rev., vol. 67, no. 8, Aug. 19, 1920, pp. 505–508, 1 fig. While building permits in United States show increase in recent months, it is generally estimated that twice as much construction would be undertaken as at present if labor conditions were more stable.

C

CABLES, ELECTRIC

Underground. Underground Electric Cables (Câbles souterrains d'alimentation), L. Sekutowiez. Industrie des Tramways et Chemins de Fer, vol. 14, nos. 161–162, May-June 1920, pp. 85–100, 14 figs. Technical conditions with which armored cables must comply. Aluminum as conductor. Data on direction of underground cables. (Concluded.) Report prepared for presentation to the International Congress which was to be held at Budapest in 1914.

Unipolar. Unipolar Cables with Lead Sheathing (Câbles unipolaires sous enveloppe de plomb), P. Capdeville. Revue générale de l'Électricité, vol. 8, no. 6, Aug. 7, 1920, pp. 177–181, 8 figs. Formulæ for calculating, for a given network, currents and voltages induced in lead and their influence on the characteristics of copper conductor.

CABLEWAYS

Timber Transportation. Ropeways for the Transport of Timber, P. Stephan. Eng. Progress, vol. 1, no. 9, Sept. 1920, pp. 279–281, 10 figs. Transport upon wooden runners and by means of field railways; ropeways for wide spans. Details of construction and economy.

CAMS

Design of. Rational Study of Mechanisms Operated by Cams (Etude rationnelle des méchanismes commandés par cames), Octave Lepersonne. Revue universelle des Mines, vol. 6, no. 2, July 15, 1920, pp. 122–126. Formula for dimensions of cam in terms of those of return springs.

CANALS

Electric Traction on. Electric Traction on Canals (La traction électrique sur les canaux), M. Tumerelle. Bulletin de la Société française des Électriciens, vol. 10, no. 89, May 1920, pp. 187–198, 1 fig. Economical study based on results of operating various canals electrically in France.

Great Lakes-Atlantic Ocean. The St. Lawrence Route and Welland Ship Canal, Alex. J. Grant. Jl. Eng. Inst. of Canada, vol. 3, no. 9, Sept. 1920, pp. 425–434, 11 figs. Origin, development and construction of canals that form navigation system connecting Great Lakes with Atlantic Ocean via St. Lawrence Route.

Locks. The Lock Foundation, Inner Harbor Navigation Canal, New Orleans, La.—The Problem and the Solution, Geo. R. Goethals. Proc. La. Eng. Soc., vol. 6, no. 3, June 1920, pp. 134–158, 8 figs. Lock is located 2000 ft., measured along canal channel, from river. Canal prism between river and lock will be 125 ft. wide, with 30 ft. minimum depth; and between lock and lake, bottom width of 150 ft. and minimum depth of 30 ft. will be provided. Unique feature is that high-level pool may be either on river side or on lake side.

Welland Ship. Progress on New Welland Ship Canal. Can. Engr., vol. 39, no. 11, Sept. 9, 1920, pp. 319–330, 24 figs. partly on supp. plate. Estimated quantities of excavation, concrete and embankments. Review of canal's history, purpose, design and construction, with special reference to 1919 and 1920 work. Program for 1921.

CARBURETORS

Kerosene. A New Kerosene Carburetor. Automotive Industries, vol. 43, no. 12, Sept. 16, 1920, p. 561, 1 fig. Kjellberg carburetor. Kerosene is mixed with portion of air required for combustion and mixture heated by exhaust heat. Further on toward inlet valves extra air is added.

CARS

Pipe Connectors, Automatic. The Beahm Automatic Connector for Train Pipes. Ry. Age, vol. 69, no. 11, Sept. 10, 1920, pp. 451–453, 5 figs. Connector differs from other types in gathering arrangement, in method of attachment to coupler and in means employed for coupling to cars not equipped with connectors.

CARS, FREIGHT

British. New Freight Rolling-Stock for British Railways. Ry. Gaz., vol. 33, no. 6, Aug. 6, 1920, pp. 186–189, 6 figs. Recently constructed covered vans and brake vans for Great Eastern and Caledonian Railways built by Clayton Wagons, Limited, of Lincoln.

Draft Gears. Draft Gear Tests, U. S. R. A.—Design, Nature and Scope. Ry. Rev., vol. 67, nos. 11 and 12, Sept. 11 and 18, 1920, pp. 383–386 and 425–429, 3 figs. Action and comparative merits of various gears from viewpoint of impact and buffing. Discussion of developments noted in rivet shearing and impact tests. (To be continued.)

CARS, REFRIGERATOR

Gas-Eliminating System. Refrigerator Car Gas Eliminating System. Ry. Mech. Engr., vol. 94, no. 8, Aug. 1920, pp. 545–546, 1 fig. Function of system is to remove from atmosphere of refrigerator the gases produced by bacterial action in breaking down of tissues of product under refrigeration, and it is designed for use with any cooling system. System has been developed and is now controlled by Acme Refrigerator Corporation, Chicago.

CASE-HARDENING

Gas Furnace for. City Gas as a Case-hardening Agent, H. M. Crawford. Metal Trades, vol. 11, no. 9, Sept. 1920, pp. 386–388, 3 figs. Results of carburizing low-carbon steel for seven hours in illuminating gas at various temperatures. Sketch of gas-carburizing furnace.

CATALYSIS

Colloidal Catalyzer. Aging of Colloidal Catalyzers—Platinum, Palladium (Sur le vieillissement des catalyseurs colloidaux (platine, palladium), Gregorio de Rocasolano. Comptes rendus des Seánces de l'Académie des Sciences, vol. 171, no. 5, Aug. 2, 1920, pp. 301–303. Experiments are said to have established that such catalyzers increase in activity with age.

CELLULOSE

Acetate, Manufacture of. Manufacture of Cellulose Acetate, Maurice Deschiens. Chem. & Metallurgical Eng., vol. 23, no. 11, Sept. 15, 1920, pp. 533–536, 1 fig. Generalities on cellulose acetates. Esterification. Operating conditions. Industrial manufacture by acetylation of modified or natural cellulose with or without solution of cellulose in esterifying bath.

CEMENT GUN

Uses. Cement Gun and Its Uses (Le cement-gun et ses applications générales), M. Bousquet. Vie Technique et Industrielle, vol. 1, nos. 10 and 11, July and Aug. 1920, pp. 294–296 and 399–402, 9 figs. Results of experiments made at experimental laboratory of the Conservatoire national des Arts et Métiers, Paris, France.

CEMENT MANUFACTURE

State-Owned Plant. Should the State Own and Operate a Plant for the Manufacture of Portland Cement? J. C. Nagle. Good Roads, vol. 20, no. 8, Aug. 25, 1920, pp. 92 and 94–95. State-owned plant, it is claimed, would stabilize market prices and reduce fluctuations.

CENTRAL STATIONS

California. The Industrial Load in California. Elec. World, vol. 76, no. 9, Aug. 28, 1920, pp. 428–430, 2 figs. Central station figures for first quarter of year indicate large increases in industrial load.

Expansion in 1920. Central-Station Expansion in 1920. Elec. World, vol. 76, no. 11, Sept. 11, 1920, pp. 518–520. Analysis of returns received indicates that about 1,500,000 kw. will be added to generating capacity of central stations in 1920

U. S. Census of 1917. U. S. Census of Central Stations 1917. Elec. World, vol. 76, no. 10, Sept. 4, 1920, pp. 476–477, 1 fig Census indicates 6542 central stations, with installed rating of 8,994,407 kw. and total output of 31,044,049,234 kw-hr. Stationary motors served number 555,924, with continued rating of 9,216,330 hp.

CERAMIC MIXTURES

Colors Produced by Nickel Oxide. A Glaze Study Involving Some Interesting Colors Produced by Nickel Oxide, J. D. Whitmer. Jl. Am. Ceramic Soc., vol. 3, no. 8, Aug. 1920, pp. 663–670. Grays were obtained in tests from oxide of nickel in presence of magnesium oxide.

CHIMNEYS

Concrete. New Concrete Chimney System. Concrete, vol. 17, no. 1, July 1920, pp. 33–34, 4 figs. Coniform design in which monolith is strengthened with series of vertical and integral ribs, half round in section, extending from bottom to top and terminating at base of ornamental top.

Stability of. The Stability of Chimneys (Die Standsicherheit der Schornsteine), Otto R. Jäcker. Zeitschrift des Bayerischen Revisions-Vereins, vol. 24, nos. 11, 12 and 13, June 15, 30 and July 15, 1920, pp. 88–91, 97–99 and 105–107, 6 figs. New basic principles evolved from the elastic behavior of the building material and the dynamic influences of wind; recommendations for standard building regulations. (To be continued.)

CHROME STEEL

Welding. Welding Heat-Treated Chrome Alloy Steel, J. Churchward. Iron Age, vol. 106, no. 11, Sept. 9, 1920, pp. 641–642, 7 figs. How controlling welding heat insured minimum of injury to original structure. Special welding machine employed. Saving defective forgings.

CHROME-NICKEL STEEL

Aeroplane-Engine Crankshafts. Establishment of Operating Conditions for the Production of Chromium-Nickel Steel for Aeroplane-Engine Crankshafts (Festlegung der Arbeitsbedindungen für die Erzeugung von Chromnickelstahl für Fliegerwellen), Erdmann Kothny. Stahl u. Eisen, vol. 40, no. 20, May 20, 1920, pp. 677–684, 1 fig. Results of a series of systematic tests showed that for furnace charge only high-grade material should be used; in order to maintain the required fibrous texture in the refined condition, even with purest charge, two oxidizing slags must be employed; a manganese content of more than 0.8 per cent renders texture in the refined condition granular, etc.

Torsion Elasticity. Torsion Elasticity of Nickel Steels with High Chromium Content (Étude de l'élasticité de torsion des aciers au nickel à haute teneur en chrome), P. Chevenard. Comptes rendus des Séances de l'Académie de Sciences, vol. 171, no. 2, July 12, 1920, pp. 93–96, 3 figs. Charts giving experimentally measured moduli of torsion of various nickel steels containing from 10 to 100 per cent chromium.

Uses in Automotive Industry. Some Applications of Alloy Steels in the Automotive Industry, H. J. French. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 501–505 and p. 547, 9 figs. Reference is made to uses of steel containing 1 per cent nickel and 1 per cent chromium and also 3 per cent nickel and 3 per cent chromium. Data are given for these two steels showing tensile properties and hardness developed in small-size rounds subjected to varying heat treatments. Mention is made of nickel-chromium steels and treatments used for gears and airplane-engine crankshafts. "Streaks" and "temper-brittleness," both encountered in use of nickel-chromium steels are discussed and curves showing tensile properties and hardness of "stainless steel" under varying oil-quenching and tempering treatments are presented, and also results of cutting tests made with cast high-speed steel milling cutters and comparison is given with high-speed cutters made by present-day ordinary methods.

CHUTES

Design. The Design of Chutes and Ore Bins, John S. Watts. Iron & Steel of Canada, vol. 3, no. 8, Sept. 1920, pp. 244–246. Slope to give for different materials. Advantages of making chute in two sections.

CLAYS

Bond Clay and Ash Mixtures. The Fusibility of Mixtures of Graphite Ash and Bond Clays, R. N. Long. Jl. Am. Ceramic Soc., vol. 3, no. 8, Aug. 1920, pp. 626–633, 6 figs. It was found in experiments that ash from Alabama graphite has higher fusion point than ash from Ceylon and is less active as flux in bond clay-ash mixtures. No eutectic was found to exist between graphite ash and bond clay.

Stoneware. The Properties of Some Stoneware Clays, H. G. Schurecht. Dept. of Interior, Bur. of Mines, Technical Paper 233, 1920, 41 pp., 23 figs.

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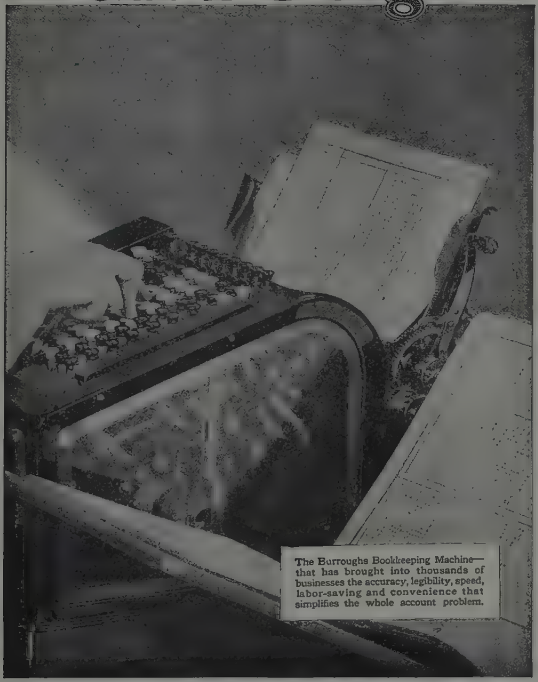

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ENGINEERING INDEX (Continued)

Investigation had special reference to possible use of Ohio and Pennsylvania clays in making chemical stoneware.

COAL

Bituminous, Production of. Is the Coal Shortage Real or Imaginary? C. E. Lesher. Coal Age, vol. 18, no. 9, Aug. 26, 1920, pp. 429–431, 1 fig. Deals only with bituminous coal. It is said that stocks are lowest in five years, that present rate of production is barely sufficient for consumption and exports and that inequalities in production and distribution make necessary an output of 11,500,000 tons per week if serious condition this winter is to be forestalled.

Briquetting. Fuel Briquetting in 1919, F. G. Tryon. Dept. of Interior, U. S. Geological Survey, 1920, pp. 33–36, 1 fig. Statistics of production. There were briquetted 295,734 tons of fuel in 1919 in U. S. List is included of briquetting plants in U. S.

Good Briquets Made of Oklahoma Coal with Crude-Oil Residue as a Binder, J. C. Davis. Coal Age, vol. 18, no. 9, Aug. 26, 1920, pp. 443–444. Briquets in tests did not smoke more than coal from which they were made and burned readily. They did not soften, disintegrate or fall through grate. Washed-coal briquets did not clinker; those from unwashed coal did. Former had heat content of 12,570 B.t.u., while washed coal from which they were made ran 12,200 B.t.u.

[See also Low-Temperature Carbonization.]

Low-Temperature Carbonization. Low-Temperature Carbonization of Coal and Manufacture of Smokeless Fuel Briquets, Harry A. Curtis. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 499–501, 3 figs. Low-temperature carbonization of coal compared with high-temperature carbonization. The "carbocoal process," retorts, machinery, etc., installed at the Clinchfield plant.

Storage. Device That Will Show the Temperature of the Depths of a Storage Pile, R. P. Nichols. Coal Age, vol. 18, no. 10, Sept. 2, 1920, pp. 485–486, 2 figs. Thornley coalometer which shows thermal conditions throughout coal pile and gives warning when rise in temperature becomes dangerous. It consists of alcohol thermometers with long pipes terminating at end in mechanism which by expansion of alcohol operates handle on dials.

Sulphur in. Determination of Sulphur Forms in Coal, Alfred R. Powell. Jl. Indus. & Eng. Chem., vol. 12, no. 9, Sept. 1920, pp. 887–890. It was found experimentally that method of Powell and Parr gives correct and accurate results. Changes are suggested in method for rapid routine work.

[See also RESEARCH, Coal and Combustion.]

COAL DISTILLATION

By-Products from. By-Products from Coal Distillation (L'extraction des différents produits de la distillation de la houille), A. Grebel. Génie Civil, vol. 77, no. 8, Aug. 21, 1920, pp. 148–153, 3 figs. Processes and installations of the Société du Gaz de Paris. (To be continued.)

COAL MINES

Humidification in. Humidification of Coal Mine Atmosphere, Joseph J. Walsh. Coal Industry, vol. 3, no. 9, Sept. 1920, pp. 451–452, 1 fig. Construction and operation of Kelly spraying head.

Signal Indicators. The Deanal Visual and Aural Indicator. Iron & Coal Trades Rev., vol. 101, no. 2737, Aug. 13, 1920, pp. 193–194, 5 figs. Apparatus in use at Birchenwood Colliery, Kidsgrove, Stoke-on-Trent, England. Essential feature is operation by action of falling metallic balls which in descending actuate through a lever the finger of an indicating dial.

Ventilation. A Portable Direct-Reading Anemometer for the Measurement of Ventilation of Coal Mines, J. T. MacGregor-Morris. Eng., vol. 110, no. 2852, Aug. 27, 1920, pp. 279–280, 4 figs. Paper read before Eng. Section, British Assn.

COAL MINING

Open-Pit, Lignite. Open Pit Mining of Brown Coal, Germany, Hubert Hermans. Coal Industry, vol. 3, no. 9, Sept. 1920, pp. 424–427, 5 figs. Mechanical equipment used, notably steam shovel used in stripping operations for removing overburden and digging machine having housing built like portal in which cars are loaded.

Pick Machines. The Eloy Pneumatic Pick. Colliery Guardian, vol. 120, no. 3111, Aug. 13, 1920, pp. 450–452, 7 figs. Pick made by Messrs. Reavell and Co., Ipswich, England.

COKE OVENS

Beehive, Waste-Gas Utilization. Waste Gases from Beehive Ovens Supply Power Needed in Star Junction Plant, Clyde R. Weihe. Coal Age, vol. 18, no. 10, Sept. 2, 1920, pp. 479–481, 3 figs. Heat given off by ordinary beehive oven during coking process may be conducted to and through boiler or boiler plant, thus generating enough power for all mining purposes. Heat per oven in 48-hour cycle supplies 21 b.hp.

By-Product. New By-Product Coke Ovens at Birmingham, W. B. Bridge and J. M. Hastings, Jr. Iron Age, vol. 106, no. 7, Aug. 12, 1920, pp. 380–382, 4 figs. Plant of 120 Semet-Solvay ovens, with complete equipment for recovery of ammonia, coal tar, benzol, toluol, solvent naphtha, naphthalene and motor benzol. Power is generated at central station by two 3600 r.p.m., d.c. general electric turbo units of 2000 kw. each and distributed at 6600 volts to various mining properties of company.

Walls, Corrosion of. The Corrosion of Coke-Oven Walls, W. J. Rees. Jl. Soc. Chem. Industry, vol. 39, no. 14, July 31, 1920, pp. 197T–198T. Experimental evidence is said to indicate that corrosion is likely to be much more severe on fireclay than on silica, alumina, or magnesite bricks.

COKE PLANTS

Wisconsin Steel Works. New Coke Plant at Wisconsin Steel Works, Gilbert L. Lacher. Iron Age, vol. 106, no. 9, Aug. 26, 1920, pp. 507–513, 14 figs. Plant consists of two 44-oven batteries and auxiliary facilities for obtaining by-products from gas. Minimum coking time of ovens with normal supply of coal is 14 hours. In every 24 hrs. 1800 tons of coal are charged and 150 ovens are pushed.

COLLOIDS

Research. Investigating Methods of the Institute for Colloidal Research at Frankfurt on the Main (Untersuchungsmethoden des Institutes für Kolloidforschung in Frankfurt a./M.), H. Bechhold. Chemiker-Zeitung, vol. 44, no. 62, May 22, 1920, pp. 381–382, 1 fig. Directions for the quick determination of degree of dispersity of colloidal solutions as applied at the institute. Describes Schemensky's improved form of the Traube stactometer.

COMBUSTION

Thermal Efficiency of. Control of Thermal Efficiency of Combustion (Contribution au contrôle du rendement thermique des foyers), Victor Lebeau. Chaleur et Industrie, no. 4, July 1920, pp. 215–220, 4 figs. Graphs for evaluating heat and temperature of combustion, and heat losses.

COMFORT STATIONS

Reinforced-Concrete. Public Comfort Station for Allentown, Pa., Charles E. Parry. Concrete, vol. 17, no. 3, Sept. 1920, pp. 77–82, 10 figs. Reinforced-concrete construction.

COMPASSES

Magnetic. Testing of Magnetic Compasses, R. L. Sanford. Scientific Papers of Bur. of Standards, Dept. of Commerce, no. 382, June 18, 1920, pp. 273–279, 4 figs. Work of Bur. of Standards on magnetic compasses undertaken at request of War Department and United States Shipping Board, consisting of studies of behavior of various types of compasses, construction of special apparatus for testing purposes and special investigations.

CONCRETE

Acid-Proofing. Bituminous Acid-Proof Coatings for Acid-Proofing Concrete Surfaces. Chem. & Metallurgical Eng., vol. 23, no. 7, Aug. 18, 1920, pp. 287–289. Condensed form of recommendations of Bureau of Standards as to coating of concrete floors, vats and tanks exposed to acids, oils and similar substances.

Compression Tests. Planning Compression Tests on Concrete, Can. Engr., vol. 39, no. 10, Sept. 2, 1920, pp. 301–303. Instructions of Am. Soc. for Testing Matls. to govern coöperative tests.

Curing. Soaking Concrete in $MgSiF_6$ and $Na_2Si_4O_8$ Solutions. Concrete, vol. 17, no. 1, July 1920, pp. 28–29, 6 figs. It is indicated that 1–1–2 concrete cured in magnesium fluosilicate solutions was improved in strength for three out of four different curing conditions. 1–2–4 concrete showed no appreciable change in strength for any of curing conditions in magnesium fluosilicate solutions, but slightly higher absorption in all cases. 1–2–4 concrete cured for various lengths of time in sodium silicate gave slightly higher strengths and slightly lower absorptive values for all different conditions. Tests were made by U. S. Bureau of Standards.

Mixing Machinery. American Concrete Mixing Machinery—I. Engr., vol. 130, no. 3374, Aug. 27, 1920, pp. 193–197, 12 figs. Designs of mixture drums with stationary axis.

Proportioning. Determination of Surface Area of Sand by Volume-Moisture Relation, R. B. Young and W. D. Walcott. Contract Rec., vol. 34, no. 35, Sept. 1, 1920, pp. 825–827, 4 figs. Tests carried out in laboratories of Hydroelectric Power Commission of Ontario as part of extended research being conducted there into problem of concrete proportioning. Paper read before Am. Soc. for Testing Materials.

Rodding. Effect of Rodding Concrete. Eng. and Contracting, vol. 54, no. 8, Aug. 25, 1920, pp. 184–186, 3 figs. Results of experiments made at University of Texas. Paper read before American Society for Testing Materials.

Stress-Deformation Relations. Determinations of Stress-Deformation Relations for Concretes under Repeated and Continuous Loadings, G. M. Williams. Eng. and Contracting, vol. 54, no. 8, Aug. 25, 1920, pp. 190–192, 4 figs. Account of experimental work. Paper presented before American Society for Testing Materials.

Tile, Manufacture of. Wightman Tile Plant Involves New Ideas in Quantity Production, Harvey Whipple. Concrete, vol. 17, no. 1, July 1920, pp. 3–7, 9 figs. Machine and auxiliary equipment designed for maximum of automatic operation in producing equivalent of over 10,000 brick per hour.

[See also RESEARCH, Concrete.]

CONCRETE CONSTRUCTION, REINFORCED

Cost Estimation. Estimating Concrete Buildings. Contract Rec., vol. 34, no. 36, Sept. 8, 1920, pp. 850–856, 21 figs. Methods of Aberthaw Construction Co. of Boston.

Plant Buildings. Modern Industrial Plant Layout A. F. Wells. Can. Manufacturer, vol. 40, no. 9, Sept. 1920, pp. 43–46, 3 figs. Reinforced-concrete building erected in Toronto for Prest-O-Lite Co. of Canada, Ltd., Can. Nat. Carbon Co., Ltd. and Dominion Oxygen Co., Ltd.

Slab. Design of Reinforced Concrete Slabs with Saw-Tooth Top, J. W. Pearl. Eng. and Contracting, vol. 54, no. 8, Aug. 25, 1920, pp. 178–179, 2 figs. Chart for graphical determination of coefficients in formula.

Standards. Reinforced Concrete Design Standards, Edward Godfrey. Concrete, vol. 17, no. 3, Sept. 1920, pp. 85–89, 3 figs. Criticizes present practice in design of rodded columns and of stirrup or short shear members, and system of determining coefficients for bending moments in flat slabs.

Beams, Diagonal Tension in. Reinforcement for Diagonal Tension in Reinforced Concrete Beams, Edward Godfrey. Concrete, vol. 17, no. 1, July 1920, pp. 15–20, 12 figs. It is claimed that in customary designs of reinforced concrete beams, reinforcement is not placed in a position to take care of diagonal tension. A system of bending reinforcing bars diagonally in direction in which diagonal tension is said to take place is offered.

Flat Slabs. New York City Concrete Flat-Slab Regulations. Eng. News-Rec., vol. 85, no. 7, Aug. 12, 1920, pp. 300–302, 2 figs. Standards adopted by Board of Standards and Appeals for uniform use of all boroughs of city.

CONDENSERS, ELECTRIC

Capacities of. Capacities and Condensers (Capacités et condensateurs), P. Bunet. Revue genérale de l'Électricité, vol. 8, no. 8, Aug. 21, 1920, pp 237–250, 11 figs. Comparative study of capacities of various forms of condensers. Examples are worked out of determination of capacities of electric circuits by means of their self-inductance. Opinion is expressed that it is possible to design high-powered condensers, which would be capable of being branched in derivation on high-tension high-power distribution systems.

CONDUITS

Air Chambers in. Researches on Conduits with Air Chambers (Recherches sur les conduites possédant des réservoirs d'air), C. Camichel. Houille Blanche, vol. 19, nos. 41–42, May-June 1920, pp. 111–113, 6 figs. Experiments at Institut Electrotechnique de Toulouse to study behavior of conduits provided with devices for relief of water hammer.

Concrete. Excavation below Arch Bridge Foundations. Public Works, vol. 49, no. 10, Sept. 4, 1920, pp. 205–208, 4 figs. Concrete conduits 25 ft. wide constructed on opposite sides of railroad bridge pier and carried down 12 ft. below pier footings on gravel retained by steel sheet piles.

Method of Building Concrete Tailrace below Stone Arch Bridge Foundation Level. Eng. and Contracting, vol. 54, no. 7, Aug. 18, 1920, pp. 155–157, 5 figs. To keep gravel under grillages from caving in, line of interlocking steel sheet piling was driven on each side of excavation, and as material was dug out, bracing timbers were introduced between two rows of piling.

Reinforced Concrete Conduit under Pressure at the Rioupéroux Hydroelectric Plant (Conduite forcée en béton armé des usines hydro-électriques de Rioupéroux), A. Waechter. Schweizerische Bauzeitung, vol. 76, no. 6, Aug. 7, 1920, pp. 59–61, 6 figs. Diameter of conduit is $8^1/_4$ ft. Length is 2017 ft.

CONNECTING RODS

Machining. Connecting Rods for the Fordson Tractor, Fred H. Colvin. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, pp. 273–277, 17 figs. Attention is directed to three-point suspension method of holding and locating connecting rods during various machining operations.

CONVEYORS

Steel-Belt. The Sandvik Steel Conveyor Belt (Stahlförderband System Sandviken), S. Michelson. Fördertechnik u. Frachtverkehr, vol. 13, no. 11, May 28, 1920, pp. 104–105, 4 figs. Describes a Swedish type of steel belt manufactured entirely in one piece in lengths up to 90 m., which is pliable, of small weight, rust-proof, is durable and easily connected and repaired.

COPPER

Cold-Rolling. The Influence of Cold Rolling on the Physical Properties of Copper, F. Johnson. Eng., vol. 110, no. 2851, Aug. 20, 1920, pp. 257–260, 9 figs. Experimental studies of critical ranges on deformation. Examination of theories which have been advanced to explain existence of critical ranges in cold-worked metals, that is, allotropic theory and recrystallization theory. Paper read before Inst. of Metals.

Extruded Rods. Extruding Brass and Copper Rods, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 1–4, 7 figs. Methods and equipment employed by Rome Brass & Copper Co., Rome, New York, in production of brass and copper rods by extrusion process.

Leaching. Leaching and Concentrating Mixed Copper Ores, Arthur Crowfoot and Kenneth H. Donaldson. Eng. & Min. Jl., vol. 110, no. 10, Sept. 4, 1920, pp. 471–474, 5 figs. Method used at experimental plant of Arizona Copper Co., which consists in regrinding, dissolution of oxidized copper in weak sulphuric acid and flotation of sulphide slimes.

Reaction with Zinc. Compounds Formed by Reciprocal Penetration of Zinc and Copper at Temperature

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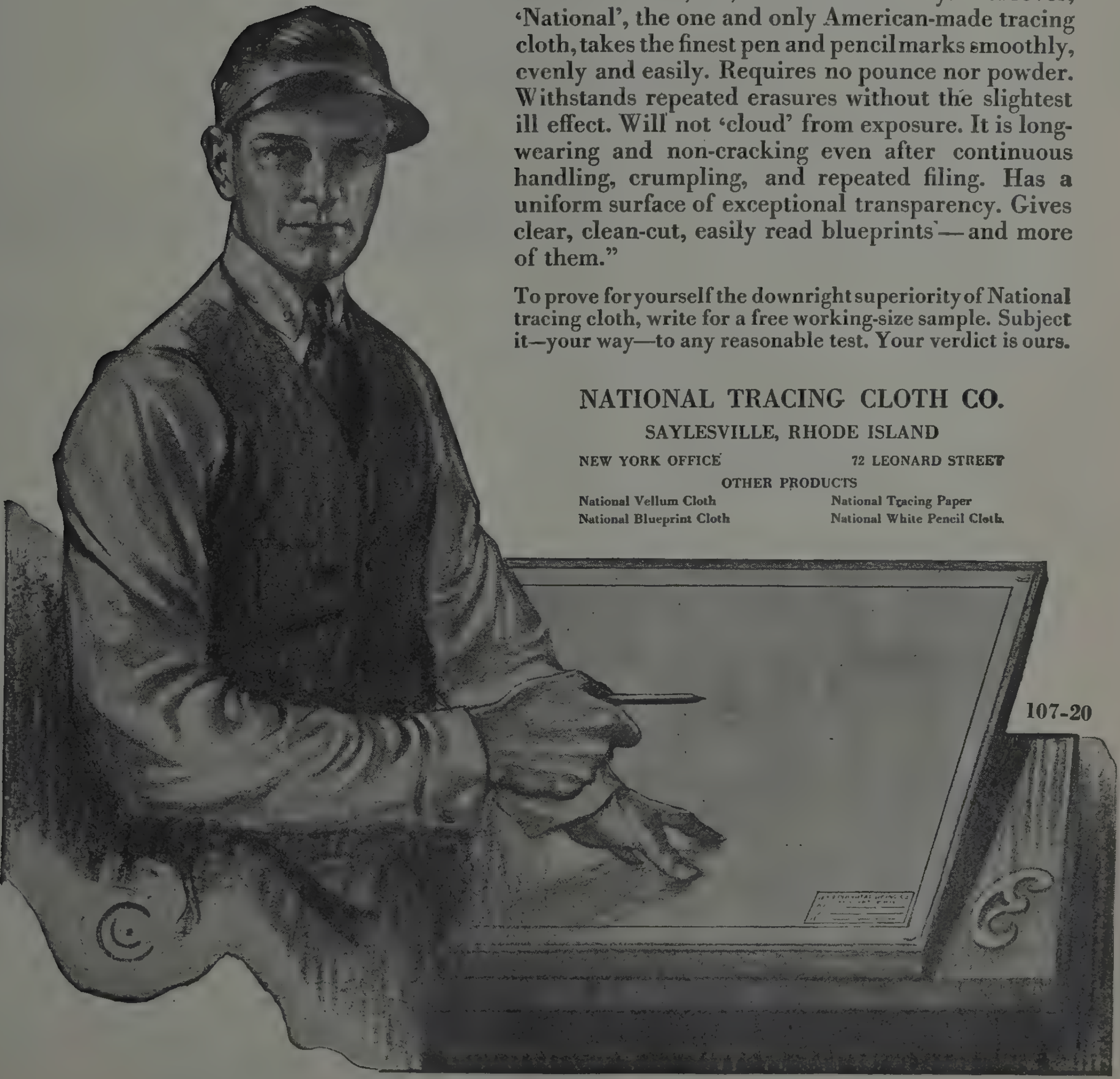

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ENGINEERING INDEX (Continued)

at Which These Two Metals and All Their Alloys Remain in the Solid State (Les constituants formés par penétration réciproque du zinc et du cuivre à une temperature où ces deux métaux et tous leurs alliages sont à l'état solide), H. Weiss. Comptes rendus des Séances de l'Académie de Sciences, vol. 171, no. 2, July 12, 1920, pp. 108–111, 2 figs. Compounds formed after heating metals for two days at 400 deg. cent.

COPPER METALLURGY

Refineries, Power Problems of. The Power Problem in a Copper Refinery, Lawrence Addicks. Chem. & Metallurgical Eng., vol. 23, no. 7, Aug. 18, 1920, pp. 275–278, 4 figs. Outline of steam recovery possible with waste-heat boilers and steam demand for heating electrolyte, with discussion of bearing of these factors upon problem of choice of prime mover.

Smelter Slag. Selecting a Slag and Apportioning Slag Losses, C. A. Grabill. Eng. & Min. Jl., vol. 110, no. 12, Sept. 18, 1920, pp. 569–572, 2 figs. Detailed method of calculating slag and matte composition from given charge. Various means of charging for copper loss. Advantages of basing it on iron contents of slag. Second of series of three articles.

CORONA

High-Voltage. The High-Voltage Corona in Air, J. B. Whitehead. Proc. Am. Phil. Soc., vol. 59, no. 4, 1920, pp. 245–260, 8 figs. Experimental testing of empirical formulæ for computing losses due to corona discharges. Construction and operation of corona voltmeter for measuring high voltage.

COSTS

England. Engineering Costs, Frank Walker. Eng. & Indus. Management, vol. 4, no. 8, Aug. 19, 1920, pp. 227–232, 3 figs. Statement of costs of labor and materials from July 1914 to June 1920, given in official organ of British Elec. & Allied Manufacturers' Assn.

CRANES

Traveling. Overhead Traveling Crane with Telescopic Cage. Engr., vol. 130, no. 3368, July 16, 1920, pp. 66–67, 2 figs. Crane is capable of lifting 120 tons and is fitted with electric turning gear at hook to facilitate manipulation of work at press and with releasing gear to prevent damage by overloads produced by action of press on work.

Traveling Crane with Lifting Magnet for the Transportation of Long Rolled Steel Sections (Laufkran mit Lasthebemagneten für den Transport von langen Walzeisen), W. Druey. Schweizerische Bauzeitung, vol. 76, no. 6, Aug. 7, 1920, pp. 64–65, 3 figs. Describes plant constructed by the Oerlikon Machine Works, consisting of a traveling crane of 5000 kg. carrying capacity and 25 m. span; two lifting magnets are suspended from each end of the 10-m. long runway, with which ten or twelve rail sections 15 to 20 m. long can be lifted and transported.

Wooden-Jib. 135-Ft. Wooden Derrick Crane Jib. Eng., vol. 110, no. 2850, Aug. 13, 1920, pp. 206–207, 6 figs. Constructed by Imber Court Engineering Works, Thames Ditton, Surrey, for British Admiralty during war. Working conditions to be fulfilled were that crane with post 50 ft. high was to lift 3-ton load up to platform 100 ft. high. Wooden construction was adopted in preference to steel in order to save weight.

CUTTING TOOLS

Barth Slide Rules. Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—XI, Carl G. Barth. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 218–225, 6 figs. Presentation of basic formulæ and construction of slide rules for milling and gear cutting.

City Gas vs. Acetylene. City Gas vs. Acetylene or Hydrocarbon for Cutting Steel, Letson Balliet. Metal Trades, vol. 11, no. 9, Sept. 1920, pp. 393–396, 1 fig. Reports of experiments of various investigators prove, it is claimed, that acetylene produces best and most efficient results.

D

DAMS

Concrete. Light Concretes and the Height of Dams (Les bétons légers et les records de hauteur des barrages), Charles Rabut. Houille Blanche, vol. 19, nos. 41–42, May-June 1920, pp. 85–87, 2 figs. Formulæ for maximum height of dam in terms of specific gravity and ultimate strength of concrete.

Curved. Gravity and Arch Action in Curved Dams, Fred. A. Noetzli. Proc. Am. Soc. of Civil Engrs., vol. 46, no. 6, Aug. 1920, pp. 950–951. Methods for determining for arch dam, proportion of load carried either by gravity, that is, vertical cantilever action, or by horizontal arching. Accuracy of method is believed to compare favorably with that obtained by purely mathematical solution of problem of arched dams. (Abstract.)

Earth. Building the Earth Dams at the Bridgewater Project, Richard Pfaehler. Eng. News-Rec., vol. 85, no. 7, Aug. 12, 1920, pp. 306–309, 5 figs. Three closures of large storage reservoirs built by sluicing earth fill into pool from dumped embankments.

Flood-Check. Flood-Check Dams Formed by Fill behind Wire Frame. Eng. News-Rec., vol. 85, no. 11, Sept. 9, 1920, pp. 506–507, 3 figs. New type of California dam automatically fills with flood debris which causes barrier.

Flood-Control. Devil's Gate Dam. Public Works, vol. 49, no. 6, Aug. 7, 1920, pp. 121–122. Flood-control dam, 310 ft. long, 130 ft. high, 2 ft. thick at top and 75 ft. at bottom, constructed, it is said, by only 21 men, thanks to labor-saving machinery and methods.

Hydraulic. Hydraulic Dams (Barrages hydrauliques). Houille Blanche, vol. 19, nos. 41–42, May-June 1920, pp. 81–85, 11 figs. Particulars of various structures. (Concluded.)

Hydraulic-Fill. Hydraulic Fill at the Miami Conservancy Dams, C. S. Hill. Eng. News-Rec., vol. 85, nos. 11 and 12, Sept. 9 and 16, 1920, pp. 486–490 and 547–550, 10 figs. Developments which have resulted from study of experiments applied to hydraulic-fill operations of Miami Conservancy District. Among these are included manganese-steel centrifugal pump which, compared with cast iron has doubled output life of pump shells and increased nearly tenfold output life of pump runners, and a new design of pump shell in white iron that has exhibited resistance to wear which indicates output life of 400,000 cu. yd. of heavy gravel and sand fill. Improved sump and pump layout reduces losses of head at suction. Manganese steel doubles and white iron quadruples pump output life.

DIE BLOCKS

Chemical Analyses. Analyzes Die Block Requirements, W. C. Peterson. Iron Trade Rev., vol. 67, no. 8, Aug. 19, 1920, pp. 517–519. Standardization of chemical analyses is urged. Squeezing die blocks is considered superior to hammering. Paper read before Am. Drop Forge Assn.

DIE SINKING

Machines. The Keller Automatic Die-Sinking Machine, S. A. Hand. Am. Mach., vol. 53, no. 4, July 22, 1920, pp. 158–160, 6 figs. Machine is designed for sinking dies such as are used for forging, glass molding, embossing, etc.

DIES

Armature Disks. The Construction of a Punch and Die for an Armature Core Disk (Herstellung eines Schnittwerkzeuges für ein Ankerblech), L. Meissler. Werkstattstechnik, vol. 14, no. 9, May 1, 1920, pp. 257–259, 20 figs. Describes tools with capacity of 700 pieces per hour and life sufficient for 5–600,000 disks.

DIESEL ENGINES

Busch-Sulzer. The Busch-Sulzer Diesel Engines, C. H. Peabody. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 752–756, 9 figs. Engines are operated on two-stroke cycle, scavenging and charging air being admitted through ports in cylinder liner, so that only fuel valve is required to be fitted in cylinder head.

Marine, Progress in Germany. Progress in Marine Diesel-Engine Building at Krupp's during the War—III, Otto Alt. Motorship, vol. 5, no. 9, Sept. 1920, pp. 804–806, 8 figs. Success of marine Diesel-engine is recorded and fundamental development of Diesel locomotives is visualized.

Skandia Werkspoor. A Pacific Coast Marine Diesel Engine. Metal Trades, vol. 11, no. 9, Sept. 1920, pp. 381–383, 1 fig. Six-cylinder single-acting four-cycle, Diesel engine rated at 1100 i.hp. and 825 b.hp. when operated at 135 r.p.m. Cylinders have $20^1/_2$-in. bore and $35^1/_2$-in. stroke.

DITCHES

Flow of Water in. Flow of Water in Ditches. Public Works, vol. 49, no. 11, Sept. 11, 1920, pp. 229–231, 3 figs. Experiments conducted by engineers of Bur. of Roads to determine proper values of coefficient in Kutter's formula for various conditions of channels in earth. Conditions are indicated by photograph, cross-section and description.

DRAINAGE

Open Ditches vs. Tile Drains. Open Ditches Excel Tile Drains for Country Roads, Frank T. Danielson. Eng. News-Rec., vol. 85, no. 9, Aug. 26, 1920, p. 401, 2 figs. Experience with hand-dug ditches constructed and maintained at small cost by village communities near Chicago.

DRILLING MACHINES

Moline Duplex. The Moline Duplex Drilling Machine, J. V. Hunter. Am. Mach., vol. 53, no. 4, July 22, 1920, pp. 147–149, 7 figs. Machines designed for rapid production. All of them are of two-head type but vary in method of operation in order to suit different classes of work.

Spindles. Recent Machine Tool Developments—XIV, Joseph Horner. Eng., vol. 110, no. 2849, Aug. 6, 1920, pp. 169–172, 15 figs. Examples of drilling spindles.

DURALUMIN

Properties. Duralumin, E. Unger and E. Schmidt. Flight, vol. 12, no. 35, Aug. 26, 1920, pp. 933–935, 10 figs. Also Aeronautics, vol. 19, no. 356, Aug. 12, 1920, pp. 135–138, 10 figs. Properties and aircraft uses. According to results obtained by various experiments duralumin has strength of 35 to 40 kg. per sq. mm., elongation of 10 to 15 per cent, stretching strain limit about 28 to 32 kg. per sq. mm., and modulus of elasticity of about 600,000 to 700,000 kg. per sq. cm. Translated from Technische Berichte.

DYES

Derivatives. Dye Derivatives of 1.3-Dioxy-Isoquinoline [Ueber Farbstoffderivate des 1.3-Dioxyisochinolins (o-Homophthalimid)], W. Herzog. Berichte der deutschen chemischen Gesellschaft, vol. 53, no. 4, Apr. 17, 1920, pp. 564–567. Account of experiments carried out at the sci. laboratory of the D. F. Pollak Artificial Resin Factory, Vienna.

E

EARTH

Subsidence of. Springs and Wells as Causes for Earth Depressions (Quellen und Brunnen als Ursachen von Bodensenkungen), H. Kegel. Braunkohle, vol. 18, no. 51, Mar. 20, 1920, pp. 681–684, 4 figs. Writer points out that such depressions are often unjustly attributed to mines and when occurring in the vicinity of springs and wells, investigation should be made if and to what extent they may be caused by these.

EDUCATION, ENGINEERING

Coöperative Course. A Coöperative Course in Electrical Engineering Conducted by Massachusetts Institute of Technology and General Electric Company, W. H. Timbie. Eng. Education, vol. 10, no. 10, June 1920, pp. 459–476. Course covers period of five years, the first two years being identical with the regular course in electrical engineering at the Institute, and the last three years being divided between instruction in theory at the Institute and training in manufacturing methods at G. E. Co.

Linking the Technical School with the Shop, Herbert R. Simonds. Iron Trade Rev., vol. 67, no. 10, Sept. 2, 1920, pp. 646–651, 9 figs. Plan adopted by Mass. Inst. of Technology in coöperation with General Elec. Co.

Metallurgical Course for Automobile Field. Metallurgical Courses for Automobile Field, H. B. Dirks. Iron Age, vol. 105, no. 18, April 29, 1920, pp. 1245–1246, 6 figs. Shop courses in foundry, forging, heat treating and similar work established by Michigan Agricultural College.

Production Engineering, Course in. What a Production Engineer Should Know, Albert McDonald. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 185–187. Outlines requirements for course in production engineering.

[See also INDUSTRIAL MANAGEMENT, Engineering Students, Training in.]

ELECTRIC CIRCUITS

Short-Circuit Calculations. A New Short-Circuit Calculating Table, W. W. Lewis. Gen. Elec. Rev., vol. 23, no. 8, Aug. 1920, pp. 669–671, 5 figs. Rheostats consist of tubular resistance elements with taps brought out and connected to buttons on back of board. On front of board is an etched dial plate calibrated in per cent reactance. Total of 104 rheostats are provided, 20 of these being connected as generators and 84 as lines.

ELECTRIC CONDUCTORS

Pointed, Discharges from. Electrical Discharges from Pointed Conductors, John Zeleny. Physical Rev., vol. 16, no. 2, Aug. 1920, pp. 102–125, 4 figs. Considerations are given for attributing lag phenomenon in point discharges to presence of non-conducting coating on discharging surfaces which may consist of adhering gas molecules. Both positive and negative point discharges from surfaces made of water, glycerine or methyl alcohol showed lag in starting.

Reduction in Temperature when Insulated. Reduction in the Temperature of a Wire when Covered with Insulation, Alec. B. Eason. Elecn., vol. 85, no. 2205, Aug. 20, 1920, pp. 202–203, 2 figs. Technical reason why wire of less than 5 mm. in diameter will remain cooler when insulated than when bare for flow of same current.

[See also ALUMINUM, Wire Joints.]

ELECTRIC CURRENTS, A. C.

Rectification. Advantages and Disadvantages of the Various Systems of Transforming High-Tension Alternating Current into Direct Current (Advantages et inconvénients des divers systemes de transformation de courant alternatif à haute tension en courant continu), F. Sarrat. Houille Blanche, vol. 19, nos. 41–42, May-June 1920, pp. 101–106, 3 figs. Comparison of costs and efficiencies. (Continuation of serial.)

Artificial Sensitizing of Galena-Metal Rectifying Contact (Sur le contact rectifiant galène-métal. Sensibilisation artificielle et remarques diverses), C. Florisson. Comptes rendus des Séances de l'Académie de Sciences, vol. 171, no. 2, July 12, 1920, pp. 106–108. Sensitization is said to be accomplished by heating galena in sulphur flame.

ELECTRIC DRIVE

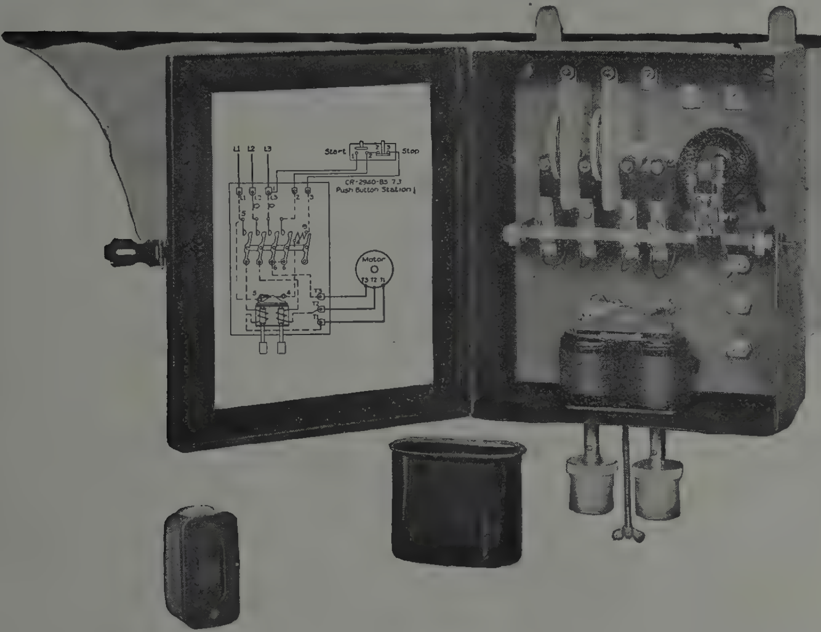
Presses, Shears, Etc. Electric Drive for Presses, Shears, Etc. (Reguliermotoren mit Arbeitsregler für Pressen, Scheren und dergl.), O. Pollok. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 27, July 3, 1920, pp. 500–504, 5 figs. Disadvantages of the hydraulic drive and of flywheels for such machines are discussed, and it is claimed that conditions required of electrically driven machines without flywheels in order that they may replace steam- or air-hydraulic machines, are fulfilled by uses of direct-current shunt motors governed by the device described in paper.

Steel-Works Blowers. The Electric Drive of Steel Works Blowers (Der elektrische Antrieb von Stahlwerksgebläsen), M. Gaze. Stahl u. Eisen, vol. 40, no. 23, June 10, 1920, pp. 783–786, 2 figs. Describes an electrically driven piston blower and points out improvements which can be attained therewith.

ELECTRIC FURNACES

Electrode Heat Losses. Heat Losses through Electrodes of a Six-Ton Héroult Furnace, M. R.

Individual motor-driven machines that start and stop frequently should have reliable motor control equipment—equipment that requires minimum maintenance



CR7006 enclosed magnetic switch consists of a triple-pole contactor or magnetically-operated switch mounted on a slate base with a two-coil gravity-reset inverse time-limit overload relay and totally-enclosed in a sheet steel case. The overload relay has a separate cover which can be readily removed for inspection of the relay or for changing adjustment.

Push Button Station—"start" and "stop," which may be installed at any convenient place near or at a distance from the switch.

CR 7006 Enclosed Magnetic Switch

This switch is suitable for controlling small alternating current motors which can be thrown directly on line.

Effective protection is afforded against motor endangering overloads by inverse time element relays that do not shut down the motor for short peak overloads.

When this switch is actuated by push button stations, operators are protected against unexpected starting of motors. When this switch is actuated by float switches or pressure governors, motors can restart immediately upon return of power.

The maintenance of the CR 7006 Switch is very low due to effective magnetic blowouts, easily renewable contacts moisture resisting operating coils and general accessibility of all parts.

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Pressure Governor—to maintain constant pressure between predetermined limits on any liquid or gas system.

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ENGINEERING INDEX (Continued)

Wolfe and V. deWysocki. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 9, pp. 65–67, 1 fig. Each electrode was provided with water-cooled ring immediately above its exit through roof of furnace; also with water-cooled connection at varying distances above roof of furnace. Total of 18.5 kw. was found to be absorbed by upper cooling contact holders, and 104.6 kw. in lower water-cooled tings.

Great Britain. Recent Developments of the Electric Furnace in Great Britain, D. F. Campbell. Jl. Soc. Chem. Industry, vol. 39, no. 14, July 31, 1920, pp. 224T–226T. On day of Armistice electrical energy, it is said, was being consumed at rate of nearly 300,000,000 kw-hr. per annum for furnace work alone. Electric steel production had then reached total of 200,000 tons per annum.

Induction. Induction Furnaces and Their Uses in the Iron and Steel Industry (Les fours à induction et leur application dans l'industrie du fer et de l'acier), W. Engelhardt. Houille Blanche, vol. 19, nos. 41–42, May-June 1920, pp. 93–101, 24 figs. Description of different types, with data on their power consumption. (Concluded.)

Nickel Resistors. Deterioration of Nickel Resistors, F. A. J. FitzGerald and Grant C. Moyer. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 4, pp. 31–34. Nickel wire was found unfit as resistor in electric furnace where it was subject to action on sulphur, because then it became brittle. Similar action was found in case of nichrome wire, but effect was not as marked.

Söderberg Electrodes. The Söderberg Electrode: First American Installation, J. W. Richards. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 2, pp. 17–24, 3 figs. Description of three-phase installation of Söderberg continuous, self-baking electrodes, 32 in. (80 cm.) in diameter, in operation at Anniston, Ala., since July 2, making ferromanganese. Furnace is 1800 kw. and operation is perfectly continuous as far as electrodes are concerned.

ELECTRIC GENERATORS

Waste-Heat, Utilization of. Utilization of the Waste Heat of Electric Generators (Ausnutzung der Abwärme elektrischer Generatoren), Alfred Reichelt. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 24, June 11, 1920, p. 177. In large electric power plants a large amount of heat is removed from the generators by the air circulated through them for cooling purposes, and writer describes how this preheated air could be supplied to furnaces in place of cold air.

ELECTRIC GENERATORS, A. C.

Automatic Excitation. Alternating-Current Automatic Excitation by Direct-Current Generators (Ueber Wechselstromselbsterregung von Gleichstrommaschinen), Fr. Leyerer. Archiv für Elektrotechnik, vol. 9, no. 2–3, July 8, 1920, pp. 95–114, 10 figs. Refers to phenomena in connection with experiments on a large three-phase turbo-generator at the Siemens-Schuckert Works and makes calculations in order to determine conditions governing same; the theoretically developed results are then compared with results of experiments.

Cascade Arrangement. Cascade Arrangement of Three-Phase Generators and Motors (Kaskadenschaltung von Drehfeldmaschinen), J. Kozisek. Elektrotechnische Zeitschrift, vol. 41, no. 23, June 10, 1920, pp. 445–448, 12 figs. A graphic method for treatment of such arrangement is developed which renders it possible to easily obtain information on most important quantities and properties of the cascade. Method is said to be especially useful in treatment of commutator cascade with three-phase shunt motors.

Parallel Operation. Modern Arrangements and Connections for the Parallel Operation of Electric Generators and Other Machines (Neuere Einrichtungen für den Parallelbetireb elektrischer Maschinen oder dgl.), W. Wolf. Elektrotechnischer Anzeiger, vol. 37, nos. 57–58, 59–60, 64, 65 and 66, Apr. 10, 14, 21, 22 and 24, 1920, pp. 243–244, 251–252, 271–272, 275–278 and 281–282, 28 figs. Details of a number of devices and arrangements by leading firms for practically eliminating oscillations and other disturbances occurring in machines operating in parallel.

Synchronous. The Asynchronous Starting Moment of the Synchronous Generator (Das asynchrone Anlaufmoment der Synchronmaschine), Ludwig Dreyfus. Archiv für Elektrotechnik, vol. 9, no. 2–3, July 8, 1920, pp. 35–94, 41 figs. Results of investigations show that the synchronous machine can develop a high starting moment if it is properly dimensioned in all parts; a properly designed damping winding is always superior to a short-circuiting ring of solid metal; a standard construction of synchronous machines with solid poles and yokes is not feasible for achievement of a high starting moment. Probable compromise is suggested.

ELECTRIC LAMPS, INCANDESCENT

Mazda. The White Mazda Lamp, Earl A. Anderson. Gen. Elec. Rev., vol. 23, no. 8, Aug. 1920, pp. 711–714, 4 figs. New type said to be specially effective in reducing glare. Bulb is made of special white glass.

ELECTRIC LOCOMOTIVES

Adhesive Weight. The Utilization of the Adhesive Weight of Electric Locomotives (Die Ausnutzung des Reibungsgewichtes elektrischer Lokomotiven), A. W. Zuidweg. Elektrotechnische Zeitschrift, vol. 41, no. 22, June 3, 1920, pp. 425–427, 2 figs. It is shown that the coefficient of friction, on which the tractive power of a locomotive depends, varies independently of speed and axle pressure, and that occasionally incorrect values and terms are found in technical literature. Recommends experiments in this direction which would be also useful in locomotive construction and the development of rapid-acting brakes.

British. British Electric Locomotives for Freight Service. Ry. Engr., vol. 41, no. 488, Sept. 1920, pp. 368–378, 12 figs. partly on supp. plate. Dimensions: Total weight, 74 tons 8 cwt.; length over buffers, 39 ft. 4 in.; height from rail to center of buffers, 3 ft. 5 in.; height of cab roof from rail, 11 ft. $6^{1}/_{4}$ in.; width of cab, 7 ft. $6^{1}/_{4}$ in.; total wheelbase, 27 ft.; diameter of wheels, 24 ft.; motor equipment of each locomotive consists of four totally enclosed motors, each driving axle through single-reduction twin gearing.

Italian State Railways. A Powerful Three-Phase Locomotive. Elecn., vol. 85, no. 2205, Aug. 20, 1920, pp. 204–206, 5 figs. Line voltage, 3000 to 3700; frequency, 15 to 17; number of traction motors, 2; number of driving wheels, coupled, 6; number of bogie wheels, 8; diameter of driving wheels, 1630 mm.; diameter of bogie wheel, 960 mm.; tractive effort 9000 kg.; power 1670 hp.; synchronous speed, 50 km./hr.

ELECTRIC MOTORS, A. C.

Development. Provisional Limitations in Electric Machine Construction (Vorläufige Grenzen im Elektromaschinenbau), W. Reichel. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 29 and 30, July 17 and 24, 1920, pp. 543–548 and 575–577, 30 figs. Notes on standard motors; development of special construction types. It is pointed out that stationary motors for conveyor plants, rolling mills, ship propulsion, etc., especially in case of three-phase current drive, have not yet reached the limits of their capacity. Transformers, converters, current generators and complete power plants are discussed. From address before Assn. German Engrs.

Synchronous. Influence of Saturation on the Operation of Synchronous Machines (Influence de la saturation sur le fonctionnement des machines synchrones), G. H. Perrin. Revue générale de l'Électricité, vol. 8, no. 3, July 17, 1920, pp. 67–73, 11 figs. Study based on Potier's diagram.

ELECTRIC RAILWAYS

Federal Commission Report. Federal Commission Report. Elec. Ry. Jl., vol. 56, no. 9, Aug. 28, 1920, pp. 398–411. Full text of report. Scope of inquiry was to ascertain actual financial and service condition of electric railways of United States at present, causes which have contributed to such conditions, what readjustments of relations between electric railways and communities which they serve must be brought about in order to restore confidence of public and to put companies upon such financial basis for future as will enable them to render continuous and efficient service to their respective communities

Oklahoma. New Interurban Railway in Oklahoma. Elec. Ry. Jl., vol. 56, no. 10, Sept. 4, 1920, pp. 449–453, 17 figs. Serves activities of oil fields. Built cross-country, with 2-deg. curves and 1 per cent maximum grade and concrete bridges designed for heavy loads, looking to future freight business.

Trolley Wire, Sag of. Determination of the Sag in Catenary Trolley Lines and Their Automatic Tightening (Bestimmung des Durchhanges bei Kettenfahrleitungen und deren selbsttätige Nachspannung), C. Wlach. Elektrotechnische Zeitschrift, vol. 41, no. 18, May 6, 1920, pp. 347 and 352–354, 6 figs. Method for calculation of relations between sag and wire tension with varying temperatures and loads.

ELECTRIC RAILWAYS, TRACK

Rail Joints. Progress in Rail Joint Construction, R. C. Cram. Elec. Ry. Jl., vol. 56, no. 9, Aug. 28, 1920, pp. 415–419. Opposite vs. staggered joints. Strength of electric bar-weld joints. Essentials for success of arc-weld type of joint.

ELECTRIC SWITCHES

Oil. Maljournal-Bourron Compression Chamber Oil Interrupter (Disjoncteur Maljournal et Bourron à chambres de compression), P. Charpentier. Revue générale de l'Électricité, vol. 8, no. 7, Aug. 14, 1920, pp. 211–215, 5 figs. Combination of compression chamber and mechanism providing rapid opening of circuit.

ELECTRIC TRANSMISSION LINES

Accounting. Utility Construction Accounting. Elec. World, vol. 76, no. 12, Sept. 18, 1920, pp. 574–575, 1 fig. Urges using accounting system on construction of transmission and distribution lines and similar undertakings.

Calculation of. Modern Methods of Designing and Operating High-Tension Electric Transmission Lines (Sur les méthodes modernes de calcul et sur le régime de fonctionnement des lignes de transmission d'énergie à haute tension), A. Blondel. Revue générale de l'Électricité, vol. 8, no. 6, Aug. 7, 1920, pp. 163–174, 8 figs. Graphs for simplifying calculations involving hyperbolic functions. (Continuation of serial.)

"Half-Wave" Lines. "Half-Wave" Electric Transmission Lines (Sur les lignes de transport d'énergie demi onde), M. E. Brylinski. Bulletin de la Société française des Électriciens, vol. 10, no. 89, May 1920, pp. 169–185. Comparative value of "half-wave" and "quarter-wave" lines for transmission of electric power at great distances.

High-Tension. Arcing Grounds on High-Tension Lines, W. D. A. Peaslee. Elec. World, vol. 76, no. 9, Aug. 28, 1920, pp. 424–427, 6 figs. Experimental investigation of the voltage stress on insulators and connected apparatus on high-tension transmission lines due to normal-frequency voltage and the high-frequency surges caused by arcing grounds.

Design and Operation of High-Tension Electric Transmission Lines (Sur ls méthodes modernes de calcul et sur le régime de fonctionnement des lignes de transmission d'énergie à haute tension), A. Blondel. Revue générale de l'Électricité, vol. 8, nos. 5, 7 and 8, July 31, Aug. 14 and 21, 1920, pp. 131–141, 195–206 and 227–236, 16 figs. Technical and graphical study. Graphical method of computing characteristics. Suggested generalization of Brown diagram. Maximum power transmissible and maximum efficiency attainable.

Induction Coefficients. Induction Coefficients of Electric Transmission Lines (Coefficients d'induction des lignes électriques), P. Capdeville. Revue générale de l'Électricité, vol. 8, no. 5, July 31, 1920, pp. 152–156, 6 figs. Process for computing coefficients by introducing return conductor necessary to consideration of flux, but limiting its position in finite space.

110,000-Volt. Transportation of Electrical Energy at 110,000 Volts between Gösgen, Switzerland, and Pouxeux, Vosges, France (Transport d'energie électrique a 110,000 volts entre Gösgen (Suisse) et Pouxeux (Vosges), P. Caufourier). Génie Civil, vol. 77, no. 4, July 24, 1920, pp. 65–69, 13 figs. Total length of line is 115 miles. Power transmitted is 15,000 kw.

Protection of. Current-Balance Relay Protection, E. R. Stauffacher. Elec. World, vol. 76, no. 10, Sept. 4, 1920, pp. 465–467, 3 figs. Necessity for development of new system of relay protection where duplicate parallel lines are operated is met by current-balance relay.

Protection of Transmission Systems—II, Emil Alm. Elec. World, vol. 76, no. 8, Aug. 21, 1920, pp. 377–380, 3 figs. Analysis of abnormal voltages which may occur on transmission systems and methods adopted by company in Sweden for the purpose of protecting station apparatus from insulation breakdown.

Stresses Due to Rupture of a Span. Elastic Equilibrium of an Aerial Line of an Indefinite Number of Spans When One Span Fails (Sur l'équilibre élastique d'une ligne aérienne formée d'un nombre indéfini de travées identiques, quand les fils d'une travée sont rompus), E. Baticle. Revue générale de l'Électricité, vol. 8, no. 4, July 24, 1920, pp. 100–102. It is assumed that the number of supports on either side of failing span is large enough to permit normal tensions to exist at certain distances from failure. Equations are derived and applied to numerical case.

Tension and Sag Calculations. Charts Show Tension and Sag for Transmission Lines. Elec. World, vol. 76, no. 11, Sept. 11, 1920, pp. 529–530, 3 figs. Charts for finding proper sag and tension when given a line to string, so that allowable stress will not be exceeded in cold or windy weather, and also to determine what sag will correspond to any given tension under present conditions.

ELECTRIC WELDING

Machines. Electric Welding Machines—Factors Influencing Their Operation, L. W. Webb. Power, vol. 52, no. 9, Aug. 31, 1920, pp. 337–338, 2 figs. Curves showing amount of reactance required in welding circuit for different values of the current employed.

ELECTRIC WELDING, ARC

Automatic Machines. Automatic Electric Arc Welding Machine, H. L. Unland. Am. Mach., vol. 53, no. 9, Aug. 26, 1920, pp. 403–406, 8 figs. Types built by General Elec. Co. Paper read before Am. Welding Soc.

Cast Iron. Welding Cast Iron with the Electric Arc, Robert E. Kinkead. Welding Engr., vol. 5, no. 8, Aug. 1920, pp. 23–24. Comparative advantages of oxy-acetylene and electric processes for welding cast iron. Paper read before American Welding Society.

ELECTRICAL APPARATUS

Testing. Polyphase Experimental and Instrument-Testing Table, H. P. Sparkes. Elec. World, vol. 76, no. 8, Aug. 21, 1920, pp. 380–381, 2 figs. Switchboard used in testing laboratory of Westinghouse Electric & Manufacturing Company for polyphase experiment tests.

ELECTROLYTIC CELLS

Cylindrical. The Cylindrical Electrolytic Cell, L. D. Vorce. Chem. Age, vol 28, no. 8, Aug. 1920, pp. 279–281, 2 figs. Comparison of cylindrical and box-shaped cells. Paper read before Am. Inst. Chem. Engrs.

ELECTRON TUBES

Development. Development of Electron Tubes—I, Marius Latour. Elec. World, vol. 76, no. 11, Sept. 11, 1920, pp. 521–524, 8 figs. Various arrangements of tubes are analyzed to show what conditions are necessary for maximum amplification. Historical development of three-electrode tube is also discussed.

Modulated Waves. An Electron Tube Transmitter of Completely Modulated Waves, Lewis M. Hull. Scientific Papers of Bur. of Standards, Dept. of Commerce, no. 381, June 18, 1920, pp. 259–271, 7 figs. Transmitter set designed and built at Bur. of Standards. Set fulfills following requirements: (1) Use of single, type "P" pliotron, with 500-cycle, 150-volt alternator; (2) power output exceeding 200 watts in an antenna having 8 to 15 ohms resistance and natural wave length below 200 m.

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ENGINEERING INDEX (Continued)

(3) readily adjustable range of wave lengths from 500 to 1000 m.; (4) transmission of completely modulated waves, making possible their reception with crystal detectors; (5) sharply tuned waves in order to avoid excessive interference over long series of tests.

EMPLOYMENT MANAGEMENT

Automobile Plants. Employment Department Increases Efficiency of Office Personnel, Norman G. Shidle. Automotive Industries, vol. 43, no. 12, Sept. 16, 1920, pp. 576–578, 9 figs. Results obtained by applying effective personnel methods in office work at large automobile plant.

Record Forms. Aids for the New Employment Manager, F. Morgan Keyser. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 245–247, 2 figs. Suggested forms for recording term of service and for showing total separations by periods.

Vocational Tests. Psycho-Technics in Germany, Alfred Gradenwitz. Am. Mach., vol. 53, no. 9, Aug. 26, 1920, pp. 407–408, 6 figs. Apparatus used in German laboratory to pick out right man for job.

ENGINEERING SOCIETIES

Federated Engineering Societies. Federated Engineering Societies of America, Arthur P. Davis. Eng. World, vol. 17, no. 3, Sept. 1920, pp. 198–201. Reasons for establishing Federated Engineering Societies. Work Federation will accomplish. Why this work cannot be accomplished by any other society.

ENGINEERS

Licensing. Legislation Governing Practice of Engineers. Contract Rec., vol. 34, no. 33, Aug. 18, 1920, pp. 784–787. Act recently passed in Nova Scotia.

ETHYLENE

Recovery from Coal. Recovery of Ethylene from Coal. Colliery Guardian, vol. 120, no. 3112, Aug. 20, 1920, p. 533, 1 fig. Process for treatment of gaseous products from coke ovens, patented jointly by Ernest Bury and Skinningrove Iron Co., Ltd.

Development of Department. How an Effective Employment Department Is Being Developed, Norman G. Shidle. Automotive Industries, vol. 43, no. 8, Aug. 19, 1920, pp. 370–373, 7 figs. It is said that large expenditures and elaborate equipment are not essential to successful operation of employment department, and that intelligent vision and progressive development are of more importance. System of records in use in employment department of Detroit automobile manufacturer is explained.

EVAPORATORS

Design. Studies in Evaporator Design—III, W. L. Badger and P. W. Shepard. Chem. & Metallurgical Eng., vol. 23, no. 9, Sept. 1, 1920, pp. 390–393, 1 fig. Effect of hydrostatic head on heat transmission in vertical-tube evaporators. Method of manipulation and accuracy of results. Maximum heating one-third tube depth. Paper read before Am. Inst. Chem. Engrs.

EXCAVATION, EARTH

Use of Explosives. Experiments Dealing with the Acceleration of Construction of Earthworks, Trenches, etc., by Means of Explosives (Ueber Versuche, betr. die Beschleunigung des Herstellens von Erdarbeiten, Gräben u. dgl. durch Sprengmittel), E. Beckmann and P. Knipping. Gesundheits-Ingenieur, vol. 43, no. 22, May 29, 1920, pp. 253–256, 7 figs. Westfalite, the explosive used for the experiments, contains 95 per cent ammonium nitrate and 5 per cent ground wood and is said to be remarkably free from danger. Use of explosives is said to effect a saving in time and labor.

[See also TIME STUDY, Power Shovels.]

EXECUTIVES

[See MANAGEMENT, Statistics, Value of.

EXPLOSIVES

Detonation, Strength and Velocity of. Strength and Velocity of Detonation of Various Military Explosives, W. C. Cope. Jl. Indus. & Eng. Chem., vol. 12, no. 9, Sept. 1920, pp. 870–873. Strength of several explosives, used or proposed for military use is given as compared with TNT, comparison being based on results of ballistic mortar test. Velocity of detonation of several military explosives was determined under known conditions of density and confinement.

F

FANS, CENTRIFUGAL

Blade Inclination. Do Fans Operate by Centrifugal Force? David W. Evans. Coal Age, vol. 18, no. 10, Sept. 2, 1920, pp. 487–489, 3 figs. Tests established that motion of blades creates partial vacuum and therefore that better type of fan is that which protects this vacuum so that only intake air can reach it. Type developed in view of this fact.

FARM MACHINERY

Darlington Show. The Royal Agricultural Show at Darlington—IV. Engr., vol. 130, no. 3368, July 16, 1920, pp. 58–59, 3 figs. Models exhibited.

FATIGUE

Industrial. Industrial Fatigue and Mental Efficiency, B. Muscio. Eng. and Indus. Management, vol. 4, no. 7, Aug. 12, 1920, pp. 206–208. Report presented to Industrial Fatigue Research Board. Tests which form basis of report were mental tests, and they were employed to investigate industrial fatigue caused primarily by continuous demand upon attention.

FERROMANGANESE

Manufacture in Great Britain. Ferromanganese Practice in Great Britain, Paul M. Tyler. Iron Age, vol. 106, no. 12, Sept. 16, 1920, pp. 711–713. Unusual feature of one furnace design is contraction from bosh and hearth which instead of being straight line, comes down on curve of 26 ft. radius.

FILTRATION

Centrifugal. A New Process of Centrifugal Filtration, W. J. Gee. Jl. Soc. Chem. Industry, vol. 39, no. 15, Aug. 16, 1920, pp. 255T–256T, 1 fig. Apparatus combining centrifugal separation with filtration through non-choking filter.

FIRE PREVENTION

Coal-Tar Chemical Works. Prevention of Fires and Explosions in Coal-Tar Chemical Works, Nicholas Richardson. Chem. & Metallurgical Eng., vol. 23, no. 7, Aug. 18, 1920, pp. 273–274. Report submitted by Underwriters' Bureau of New England to Atlantic Dyestuff Co., Boston.

FIRE PROTECTION

Static Electricity. Elimination of Danger of Fire from Electrically Excited Inflammable Liquids (Ueber die Beseitigung der Brandgefahren bei elektrisch durch Strömen erregten feuergefährlichen Flüssigkeiten), H. Holde. Feuerwehrtechnische Zeitschrift, vol. 8, no. 9–10, May 5–20, 1920, pp. 73–77, 2 figs. Experiments and theoretical studies show that the grounding of all metallic pipes and containers, such as tanks and other reservoirs, which come in contact with electrically excited liquids, is entirely adequate for preventing ignition.

FIRECLAYS

British. The Composition, Drying and Firing Shrinkage, Porosity, and Density of British Fireclays Suitable for Glass Furnace Refractory Materials, Edith M. Firth, F. W. Hodkin and W. E. S. Turner. Jl. Soc. of Glass Technology, vol. 4, no. 14, Aug. 1920, pp. 162–205, 27 figs. Chemical analyses of 27 different clays, drawn from various sources in England, Wales and Scotland and measurements of their shrinkages, porosities, apparent and actual densities at long series of temperatures up to 1400 deg. cent., and information concerning their working properties and their color changes when fired.

FITS

Fiber Stresses. Determination of Fiber Stress Caused by Force Fits. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 533–534, 2 figs. Charts based on Birnie's formula for thick, hollow cylinders, adapted to case where external pressure is zero.

[See also GAGES, Tolerances.]

FLIGHT

England to Australia. From England to Australia in a Giant Aeroplane (Im Grossflugzeug von England nach Australien), Roland Eisenlohr. Motorwagen, vol. 23, no. 17, June 20, 1920, pp. 306–308, 2 figs. Describes remarkable flight of the Smith brothers over a distance of 18,200 km. in period of thirty days, with details of the Vickers-Vimy plane used in flight which is said to show evidence of influence of German construction, especially of the newer type of Gotha machine delivered to England according to Treaty terms, and to prove that for such long and difficult flights, only machines with two or more engines can be considered.

FLOOD CONTROL

Miami Project. Principles of Channel Improvement in Miami Valley Flood Protection. Eng. News-Rec., vol. 85, no. 7, Aug. 12, 1920, pp. 292–298, 10 figs. Flow capacity of river increased to supplement action of detention basins. Bottom of enlarged channel shaped for low-water flow. Scour protection by concrete revetment, block mattresses and sills.

FLOORS

Tile and Concrete. Tile and Concrete Floor Shows to Advantage under Test. Am. Architect, vol. 118, no. 2329, Aug. 11, 1920, pp. 193–199, 5 figs. Investigation by Bur. of Standards. Purpose was to obtain data to serve as basis for design of concrete and hollow-tile floor reinforced in two directions.

FLOW OF FLUIDS

Turbulent Motion. On the Conditions at the Boundary of a Fluid in Turbulent Motion, T. E. Stanton, Dorothy Marshall and Mrs. C. N. Bryant. Proc. of Roy. Soc., vol. 97, no. 687a, Aug. 3, 1920, pp. 413–434, 11 figs. Experimental research into phenomena of skin friction of solid surfaces due to flow over them of fluids whose motion, not in immediate vicinity of surface, is eddying or turbulent.

FLYING BOATS

Beardmore Amphibian. Beardmore 10 Passenger Amphibian Flying Boat, W. B. 9. Aeronautics, vol. 19, no. 357, Aug. 19, 1920, pp. 147–149, 4 figs. Dimensions: Span, 107 ft.; overall length, 61 ft.; extreme height, 20 ft. 6 in.; total weight, 14,000, lb.; wing area, 2202 sq. ft.; speed on ground level, 93 m.p.h.; at 10,000 ft., 82 m.p.h.; climb to 10,000 ft., 38 min.; ceiling, 11,000 ft.

Hulls. Note on Flying Boat Hulls, Linton Hope. Aeronautical Jl., vol. 24, no. 117, Sept. 1920, pp. 495–497. Tables showing dimensions and particulars of hulls in 20 prominent types.

Notes on Flying Boat Hulls, A. R. Low. Aeronautical Jl., vol. 24, no. 116, Aug. 1920, pp. 440–460 and (discussion) pp. 461–471, 20 figs. Survey of developments in outline, weight, dimensions, etc.

FOREMEN

Handling Men. A Practical Talk to Foremen, George D. Halsey. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 196–199. Fundamental principles of handling men.

FORGE PLANTS

Heat Saving in. Where Electricity Is a By-Product. Power, Plant Eng., vol. 24, no. 18, Sept. 15, 1920, pp. 871–875, 11 figs. Exhaust steam from large number of steam hammers is used to generate electricity and heat feedwater for drop-forging plant at West Pullman, Ill.

FORGING

Forge Shops. Builds Forge Shop in Pittsburgh. Iron Trade Rev., vol. 67, no. 5, July 29, 1920, pp. 298–300, 5 figs. Output, 800 tons monthly. Forges are made of nickel, nickel-chrome or carbon steel and are used for making automobile, tractor, railroad car and machine tool parts.

FOUNDATIONS

Bearing Value of Soils. Progress Report of the Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations. Proc. Am. Soc. of Civil Engrs., vol. 46, no. 6, Aug. 1920, pp. 905–941, 26 figs. Object of investigation was to ascertain whether laws of earth resistance and bearing value of soils admitted codification so as to furnish basis for standardization of practical design, and to plan researches with that object in view. Conclusion is that such codification cannot be based on purely frictional theory of earth resistance such as Coulomb and Rankine theories, but must be based on theory of elastic equilibrium with frictional equilibrium as limiting state determining discontinuities of field. Work was done in coöperation with Bur. of Standards.

Footings. Footings for Foundations (Étude sur les fondations par empattements), Aimé Willame and Henri Chenu. Annales des Travaux Publics de 16 figs. Exemplification of design formulæ.

Load Pressure. Doubly Eccentric Load Pressure on Rectangular Footings, Marshall G. Findley. Eng. News-Rec., vol. 85, no. 11, Sept. 9, 1920, pp. 494–495, 2 figs. Diagram for computing pressures on doubly eccentric footings.

FOUNDRIES

Steel. Transportation Is Factor in Increasing Output of Steel Foundry, H. E. Diller. Iron Trade Rev., vol. 67, no. 12, Sept. 16, 1920, pp. 774–779, 11 figs. Inter-department transportation system in operation at plant of foundry of Fort Pitt Steel Casting Co., McKeesport, Pa.

[See also TESTING MACHINES, Foundries; TIME STUDY, Foundries.]

FOUNDRY EQUIPMENT

Steel Flasks. Fabricating Steel Foundry Flasks. Iron Trade Rev., vol. 67, no. 5, July 29, 1920, pp. 305–308, 15 figs. Rigidity is obtained by forming ribs on 3-inch centers. Bottom half of each rib is made shallow to provide shoulder upon which sand rests. Diversified uses of flasks.

FUELS

Coal vs. Oil. Coal vs. Oil Performance Chart, L. C. Lichty. Heat & Vent. Mag., vol. 17, no. 9, Sept. 1920, pp. 47–48, 2 figs. Chart for computing efficiency that may be expected in changing from one fuel to the other.

Coal Versus Oil Performance Chart. Power, vol. 52, no. 10, Sept. 7, 1920, pp. 402–403, 2 figs. Chart for determining efficiency to be expected in changing from one fuel to the other.

Comparative Cost. Comparative Cost of Fuels, M. Kinoshita. Dom. Eng. (Lond.), vol. 40, no. 20, Aug. 1920, pp. 123–124, 1 fig. Alignment chart indicating actual cost of obtaining 100,000 B.t.u. and 1 hp-hr. as mechanical energy from solid, liquid and gaseous fuel, and also electric energy, for given price, calorific value and efficiency.

Economy. Fuel Economy. Engr., vol. 130, no. 3374, Aug. 27, 1920, pp. 196 and 198. Report of committee appointed for investigation of fuel economy, utilization of coal and smoke prevention, presented at meeting of Chemistry section, British Assn. for Advancement of Science. Among subjects discussed are future standards of gas supplies and alcohol from coke oven gas.

Exhaust Gases from. Calculation of Charts for Analysis of Exhaust Gases (Berechnung von Schaubildern zur Abgasanalyse), H. Seufert. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 27, July 3, 1920, pp. 505–507, 2 figs. For solid, liquid and gaseous fuels, formulæ are derived for calculation of charts, which consist of two superimposed systems of coördinates and with which it is possible to read two of the four quantities, CO_2, O_2, and CO content, and air factor, when the other two are given.

Liquid. Calorific Power of Liquid Fuels (Pouvoir calorifique des combustibles liquides), H. Décluy. Journal des Usines à Gaz, vol. 44, no. 13, July 5, 1920, pp. 195–196. Table of equivalents with coal.

[See also COAL; LIGNITE; PULVERIZED COAL.]

FURNACES, ANNEALING

Stoker-Fired Tandem. Sheet, Pair and Annealing Furnaces—I, C. F. Poppleton. Iron Age, vol. 106, no. 12, Sept. 16, 1920, pp. 714–717, 2 figs. Typical tandem combination sheet and pair furnaces

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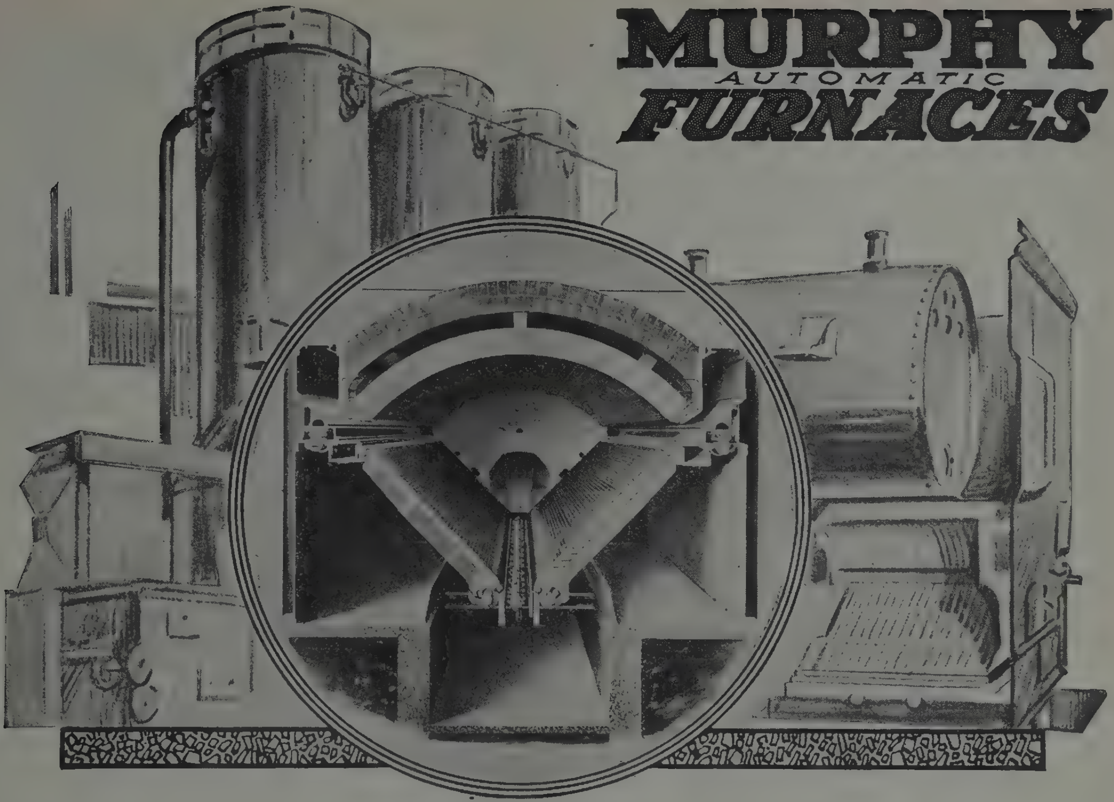

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ENGINEERING INDEX (Continued)

originally designed for use of producer gas and later changed to be stoker-fired. Pair hearth is flat and covered with specially corrugated tiles. It is arranged with two doors and pairs are charged to back and front of hearth alternately. Stoker is placed centrally on longitudinal center line of sheet and pair furnace with its combustion grates on either side of feeding worm. (To be continued.)

FURNACES, BOILER

Two-Stage. Two-Stage Combustion (La combustion en deux temps), Henry Dieterlen. Chaleur et Industrie, no. 4, July 1920, pp. 206–214, 17 figs. Boiler furnace said to have been developed from results obtained in extensive experimental researches of combustion. Furnace consists of four parts: Continuous furnace with mechanism for regulating proportions of fuel and air; first boiler element intended to cool gases to temperature near minimum at which they can be reignited; mechanism for thoroughly mixing cooled gases; second boiler element where exchange of heat takes place. Furnace is said to be capable of application to any type of boiler and for burning any fuel.

FURNACES, HEAT-TREATING

New Type. New-Heat Treating Furnace. Iron Age, vol. 106, no. 11, Sept. 9, 1920, p. 644, 2 figs. Similar to pusher type. It has no skid rails or other metal in floor, all beams being covered with fire tile. Manufactured by Advance Furnace & Eng. Co., Springfield, Mass.

FURNACES, HEATING

Rolling Mills. Experimental Study of Reheating of Metallic Pieces in Forging Furnaces (Études expérimentales sur le réchauffage des pièces métalliques dans les fours de forge), Felix Verdeaux. Revue de Métallurgie, vol. 17, no. 5, May 1920, pp. 312–334, 23 figs. Experiments with continuous and non-continuous furnaces with automatic and non-automatic grates, of type usually employed in rolling mills.

G

GAGES

Interchangeable Manufacture. Gages in Interchangeable Manufacturing—I and II, Earle Buckingham. Machy. (Lond.), vol. 16, nos. 411 and 413, Aug. 12 and 26, 1920, pp. 576–582 and 637–642, 39 figs. Types of gages and gaging devices employed in manufacturing interchangeable parts.

Lapping. Accurate Lapping, L. J. Vorhees. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, pp. 263–265, 3 figs. Instructions for gage lapping and for making laps.

Limit Plug. Quantity Production of Combination Limit Plug Gages. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 59–61, 4 figs. Description of new system of limit plug gages developed by Taft-Pierce Mfg. Co., and methods employed in their manufacture on quantity production plan. Limit plug gage made to this system consists of (1) gage handle, (2) "go" plug gage unit, (3) "not go" plug gage unit, (4) and (5) screws for holding gage units to handle. Principle advantage is possibility of interchanging gage units according to actual limits required in any one case.

Manufacture. Elements of Gage Making—IX and X, C. A. Macready. Am. Mach., vol. 53, nos. 4 and 6, July 22 and Aug. 5, 1920, pp. 167–169 and 253–255, 11 figs. Fixtures for grinding of radii to points of tangency. Use of sine bar as means to obtain greater degree of accuracy.

Planer-Tool-Setting. Precision Type of Planer-Tool-Setting Gage. Machy. (Lond.), vol. 16, no. 414, Sept. 2, 1920, pp. 681–683, 4 figs. Tool-setting gage provided with Vernier for obtaining direct readings and with means for securing quick and accurate adjustments.

Screw, Hardening of. The Hardening of Screw Gages with the Least Distortion in Pitch, Wilfrid J. Lineham. Am. Mach., vol. 53, no. 12, Sept. 16, 1920, pp. 547–551, 14 figs. Hardening of screw gages at Goldsmith's college to find means of quenching steel after heating so that distortion along pitch line should be reduced to minimum. Paper read before Instn. Mech. Engrs.

Tolerances. Chart for Determining Fit Allowances, J. B. Conway. Machy. (N. Y.), vol, 27, no. 1, Sept. 1920, p. 17. Chart for determining tolerances and limits to be allowed for various classes of fits.

[See also SCREW THREADS, National Screw Thread Commission]

GAS ENGINES

Blast-Furnace-Gas Operated. Gas Blowing Engines at Jarrow. Iron & Coal Trades Rev., vol. 101, no. 2739, Aug. 27, 1920, pp. 260–262, 5 figs. Notable feature is casting of cylinder body in two halves, each half being cast with valve portion at bottom and with large head of metal above central flange. Two halves are hydraulically forced over liner. Pistons, built according to Galloways' patent, are water-cooled.

Modern Types. Modern Large Gas Engines, H. Dubbel. Eng. Progress, vol. 1, no. 9, Sept. 1920, pp. 282–286, 12 figs. Details of Nürnberg, Körting and other types.

GAS MANUFACTURE

Lignite Gas. Lignite for Gas Making, W. D. Wilcox. Gas Rec., vol. 18, no. 4, Aug. 25, 1920, pp. 11–14. Tests. Gas from sub-bituminous coal had heat value of about 550 B.t.u.; lignite gave gas slightly better than 450 B.t.u. before purification.

[See also WATER GAS.]

GASES

Compressed, Containers for. High-Pressure Seamless Steel Cylinders. Iron Age, vol. 106, no. 7, Aug. 12, 1920, pp. 377–379, 12 figs. How containers for gases are made from tubes by piercing process and from flat plates by cupping process.

High Temperatures, Raising to. A Dynamical Method for Raising Gases to a High Temperature Without the Use of High Pressures, W. H. Watkinson. Eng., vol. 110, no. 2852, Aug. 27, 1920, p. 276, 2 figs. Also Engr., Aug. 27, 1920, p. 198, 2 figs. Principle is that if air be allowed to flow from atmosphere through spring-loaded wire-drawing valve adjusted so that air in cylinder during charging stroke is constant at pressure of one-quarter of an atmosphere, and if this air is subsequently compressed to atmospheric pressure, then, assuming adiabatic and frictionless conditions and neglecting effect of clearance in pump cylinder, absolute temperature of air at end of compression will be approximately $1^1/_2$ times absolute temperature of outside atmosphere. Paper read before Eng. Section, British Assn. for Advancement of Science.

Light Scattering by. A Re-examination of the Light Scattered by Gases in Respect of Polarization, Lord Rayleigh. Proc. of Roy. Soc., vol. 97, no. 687a, Aug. 3, 1920, pp. 435–450, 7 figs. Table giving actual angular setting of nicol required to equalize images in each case, and also intensity of weak component polarization, taking strong one as 100.

GASOLINE

Distillation. Durability of Electric Heaters for Gasoline Distillation, W. A. Jacobs and E. W. Dean. Chem. & Metallurgical Eng., vol. 23, no. 8, Aug. 25, 1920, pp. 343–344. Bureau of Mines electric gasoline distillation heater and commercial device sold for same use were subjected to life tests at maximum current load. Each failed at end of approximately 500 hr. Bureau heater through deterioration of resistance wire, and commercial heater through disintegration of block of insulating material holding resistance wire. From reports of Investigations, U. S. Bureau of Mines.

Production from Heavy Oil Hydrocarbons. Production of Motor Gasoline from Heavy Oil Hydrocarbons, Fred W. Padgett. Chem. & Metallurgical Eng., vol. 23, no. 11, Sept. 15, 1920, pp. 521–525, 3 figs. Study of possible reactions taking place in cracking phenomena, noting particularly action of catalysts upon heating and composition and refining of pyrolytic distillates.

Quality. Motor Gasoline Survey of Bureau of Mines. Automotive Industries, vol. 43, no. 12, Sept. 16, 1920, pp. 575 and 583, 1 fig. Tests of samples taken in various large cities of country during latter part of July compared with similar tests made in January last. Increase in average boiling point regarded as seasonal change.

Substitutes. Alternatives to Motor Spirit. Petroleum Times, vol. 4, no. 82, July 31, 1920, pp. 131–132. Report of British Fuel Research Board.

Survey in U. S. Internal-Combustion Engine Gasoline Survey, N. A. C. Smith. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 300–301. Curves showing how average distillation of gasoline samples secured from principal cities in U. S. in Bur. of Mines surveys compares with Government specification.

GASOLINE ENGINES

Tolputt Slide-Valve. The Tolputt Slide-Valve Engine. Autocar, vol. 45, no. 1297, Aug. 28, 1920, pp. 371–372, 2 figs. Cylinder block with slide valve gear, intended to take place of ordinary poppet-valve cylinders on crankcase of existing engine.

GEAR CUTTING

Sharpening Cutters. Sharpening Hobs and Cutters, Carl G. Olson. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 11–13, 14 figs. Points to be considered in obtaining good results in cutting of gears.

Spur-Gear Machine. New Spur Gear Generating Machine. Machy. (Lond.), vol. 16, no. 414, Sept. 2, 1920, pp. 684–685, 4 figs. Massive puncher slotting machines, in which bed and head are cast together to insure rigidity designed and constructed by William Muir & Co., Ltd., Manchester, England.

[See also HOBBING MACHINES.]

GEARS

Elliptic. The Manufacture of Elliptic Gears (Construction des engrenages elliptiques), P. Massot. Ouvrier Moderne, vol. 3, no. 1, April 1920, pp. 1–5, 4 figs. Milling method.

Horsepower Charts. A Horsepower and Torque Chart, John S. Watts. Am. Mach., vol. 53, no. 4, July 22, 1920, p. 191, 1 fig. Chart for determining sizes of gears or pulleys required to transmit given horsepower at speed given in r.p.m.

Horsepower Chart for Gear Teeth, William W. Gaylord. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 62–63, 1 fig. Chart from which horsepower transmitted by gear can be read when load is known.

Intermittent-Motion. A Mutilated Gear Feed, William Gumprich. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, pp. 250–252, 3 figs. Modification of Geneva stop.

Involute. The Involute Gear, Francis W. Shaw. Machy. (Lond.), vol. 16, no. 412, Aug. 19, 1920, pp. 630–632. Argument against contention of A. Fisher (see Machy. pp. 388 and 517) that Fisher gear reduces pressure.

GLASS

Soda-Magnesia. The Density of Soda-Magnesia Glasses, S. English and W. E. S. Turner. Jl. Soc. of Glass Technology, vol. 4, no. 14, Aug. 1920, pp. 153–156, 2 figs. Graph showing results obtained experimentally for both lime- and magnesia-containing glasses, densities in each case being plotted against molecular percentage composition. In both cases relationship between density and composition is linear, deviation occurring being at end of series only.

Tubing, Discoloration of. The Discoloration Produced by Lead, Antimony, and Arsenic in Lamp-worked Glass Tubing, F. W. Hodkin and W. E. S. Turner. Jl. Soc. of Glass Technology, vol. 4, no. 14, Aug. 1920, pp. 158–161. Results showed that both arsenious and antimony oxide are very potent in causing discoloration when glass is worked in flame, far more so than lead oxide. Minimum amount of arsenious and antimony oxides required to be present in glass to yield discoloration lies between 0.02 and 0.05 per cent; for lead oxide 0.6 per cent is required.

GLASS MANUFACTURE

Gas-Fired Furnaces. On a New Type of Gas-Fired Furnaces, Morris W. Travers. Jl. Soc. of Glass Technology, vol. 4, no. 14, Aug. 1920, pp. 205–225, 2 figs. Operation of Dennis Simplex furnaces.

GLASS, OPTICAL

Pots, Casting. The Casting of Pots for Use in Experimental Work on Optical Glass, Alice B. Taylor. Jl. Soc. of Glass Technology, vol. 4, no. 14, Aug. 1920, pp. 140–150 and (discussion) pp. 150–153, 10 figs. partly on 5 supp. plates. Advantages of casting compared with modeling or handmolding.

GLUES

Aeroplane. Experiments with Hot and Cold Glue (Versuche mit Warm- und Kaltleim), H. Franz. Dingler's polytechnisches Jl., vol. 335, no. 12, June 1920, pp. 136–138, 4 figs. Results of experiments with casein glue which, it is said, was used exclusively during war in construction of army aeroplanes because of its greater resistance to water as compared with leather and bone glues. Other advantages of casein glue are said to be rapid application and immediate use in cold state, saving of heating appliances and steam or other means of heating.

GOLD

Recovery from Magnetic Black Sand. Recovery of Gold from a Magnetic Black Sand, John A. Davis and John Gross. Reports of Investigations, Bur. of Mines, serial no. 2158, Aug. 1920, 5 pp. Tests made by Alaska section of Bur. of Mines.

GRAIN BINS

Reinforced-Concrete. Design of Circular Reinforced Concrete Bins, William Wren Hay. Concrete, vol. 17, no. 3, Sept. 1920, pp. 73–76, 7 figs. Formulæ for determining lateral pressure of walls, and graph for computing proper spacing of reinforcing steel rods.

GRAIN ELEVATORS

Sydney, Australia. Terminal Wheat Elevator, A. Stanley Ridley. Commonwealth Engr., vol. 7, no. 11, June 1, 1920, pp. 327–329, 3 figs. Structure at Sydney, Australia, with total capacity of 6,385,000 bu. Included in plant are drying house, truck shed, shipping gallery system and traveling wharf gantries. Plant is to be electrically driven.

GRAVEL PLANTS

Equipment. New Type of Sand-Gravel Plant. Rock Products, vol. 23, no. 18, Aug. 28, 1920, pp. 34–37, 14 figs. Pumping is done directly into head screen instead of dewatering sump as majority of plants do.

GRINDING MACHINES

British. Jones & Shipman Grinding Machine Developments. Machy. (Lond.), vol. 16, no. 413, Aug. 26, 1920, pp. 650–652, 4 figs. All-gear work head and surface-grinding attachment.

H

HANDLING MATERIALS

See TERMINALS, MARINE.

HEAT PUMPS

Uses. The Heat Pump (Die Wärmepumpe), H. Dahme. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 21 and 22, May 21 and 28, 1920, pp. 153–154 and 162–165, 10 figs. Details of various new types of compression vaporizers, equipped with heat pumps by means of which the compressed vapors are forced to give up their latent heat.

HEAT TRANSMISSION

See BOILERS, Heat Transfer in Flues.

HEAVY-OIL ENGINES

Steinbecker. The Steinbecker Four-Stroke Engine (Der Steinbecker Viertakt-Motor), Ernst Neuberg. Oel- u. Gasmaschine, vol. 17, no. 5, May 1920, pp. 65–71, 16 figs. Advantages over Diesel engine: Manufacturers of Diesel engines who wish to change to Steinbecker engines have only to alter cylinder head of model; cost of construction is 20 to 35 per cent less; requires no adjustment as in case of Diesel engine because of its regulating mechanism; elimination of compressor increases saving in fuel by at least 5 per cent, reduces freight and installation

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ENGINEERING INDEX (Continued)

costs, simplifies manipulation of engine and increases safety of operation; operating costs are reduced by use of low-grade fuels not practicable for Diesel engines.

HELICOPTERS

See AEROPLANES, Helicopters; Lacoin-Damblanc-"Alerion."

HELIUM

Production and Uses. Helium: Its Production and Uses, J. C. McLennan. Nature (Lond.), vol. 105, nos. 2650 and 2651, Aug. 12 and 19, 1920, pp. 747–751 and p. 778, 1 fig. Account of investigation undertaken under auspices of Board of Invention and Research of British Admiralty.

HOBBING MACHINES

Precision Work. Making a Hobbing Machine for Precision Work, Simeon Colley. Am. Mach., vol. 53, no. 11, Sept. 9, 1920, pp. 491–494, 11 figs. Design and construction of special hobbing machine for producing wormwheels of accuracy required for azimuth heads.

HOISTING

Horsepower Required in. Hoisting Problem, Fred C. DeWeese. Power Plant Eng., vol. 24, no. 18, Sept. 15, 1920, p. 891, 1 fig. Chart showing horsepower required and cable stress for hoisting load of 2000 lb. up various inclines.

HOISTS

Skip. New Skip-Hoist Designed, Warren Travell. Coal Trade Jl., vol. 51, no. 37, Sept. 15, 1920, pp. 1043–1044. Machine combining horizontal transportation with hoisting operation.

HOSPITALS

Shop. The Machine Shop Hospital, Sanford DeHart. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 38–40, 1 fig. Operation of shop hospital at plant of R. K. LeBlond Machine Tool Co., Cincinnati.

HOUSES

Slag-Sand Brick. Construction of Houses with Slag-Sand Brick (Heimstättenbau in Schlackensand-Profilsteinen), A. Guttmann. Stahl u. Eisen, vol. 40, no. 27, July 8, 1920, pp. 909–912, 14 figs. Experiences in Westphalia show that blast-furnace slag-sand brick will probably fulfill requirements of small-house construction in limited industrial districts to a marked degree.

HOUSES, CONCRETE

Monolithic Construction. Systems of Monolithic Concrete House Construction. Eng. and Contracting, vol: 54, no. 8, Aug. 25, 1920, pp. 179–182, 8 figs. Description of various systems of molds used in constructing monolithic concrete houses. From proceedings of national conference on Concrete House Construction.

Specifications. Specifications for Cement Concrete Buildings. Concrete and Constructional Eng., vol. 15, no. 8, Aug. 1920, pp. 539–541. Specifications for cement concrete building approved by British Ministry of Health.

HOUSING

Akron Rubber Companies. Building Industrial Communities, A. J. Hain. Iron Trade Rev., vol. 67, no. 7, Aug. 12, 1920, pp. 441–444, 7 figs. Housing scheme constructed by Akron Rubber Companies, involving business centers, recreation facilities and even trade "university."

Financing. Methods of Financing Housing Schemes. Contract Rec., vol. 34, no. 35, Sept. 1, 1920, pp. 830–832. Several plans outlined at Nat. Conference on concrete-house construction.

Winnipeg Scheme. Homes Built under Winnipeg Housing Scheme, F. H. Parr. Contract Rec., vol. 34, no. 35, Sept. 1, 1920, pp. 835–836, 2 figs. Terrace houses most economical, but difficult to sell. Description of semi-detached cottages. Permanent class of construction.

HOWITZERS

British 12-In. 12-Inch Howitzer on Railway Truck Mounting. Engr., vol. 130, no. 3374, Aug. 27, 1920, pp. 204 and 209, 3 figs. Howitzer consists of nickel-steel barrel which is wound with successive layers of wire ribbon over breech portion for about one-third of its length. Jacket is shrunk on whole length of barrel.

HYDRAULIC TURBINES

Development. Evolution of the Modern Hydraulic Turbine (Les turbines hydrauliques modernes et leur évolution), Denis Eydous. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, vol. 73, nos. 1–2–3, Jan.–March 1920, pp. 93–124, 15 figs. Modern turbines for medium and high heads are considered as highly perfected and being susceptible of only minor improvements concerning minor mechanical details. Turbines for utilizing variable low heads can be designed, it is believed, with several wheels mounted on the same axis, water being admitted on only part of these when head is high and on all together when it diminishes.

Kaplan. The Kaplan Hydraulic Turbine. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 516–517, 5 figs. Development of Francis type. Water flows throughout runner in axial direction and deflection of water in runner is eliminated. Guide apparatus is designed in same manner as in conventional Francis turbines, but vanes are so arranged that water discharges not only along longitudinal edges, but also at front edges. Translated from Zeitschrift des Bayerischen Revisions-Vereins.

HYDROELECTRIC PLANTS

California. High Sierras Hydro-Electric Developments. Elec. World, vol. 76, no. 11, Sept. 11, 1920, pp. 513–515, 2 figs. Generating stations with total of 850,000 kw. which will produce 4,000,000,000 kw. hr. per annum are included in 1920 to 1930 construction programs of Southern California Edison Co. and San Joaquin Light & Power Corp. of California.

Dalmatia. The 100,000-Hp. Hydraulic Plant Gubavica near Duare, Dalmatia (Die 100,000-PS-Wasserkraftanlage Gubavica bei Duare, Dalmatien), P. Zigerli. Schweizerische Bauzeitung, vol. 76, nos. 3 and 4, July 17 and 24, 1920, pp. 23–26 and 35–39, 16 figs. Details of head-water canal, supply conduit, reservoir, pressure mains, machine house, long-distance line, construction costs and other data. (Concluded.)

France. From Draft Tubes to Penstock (Installation hydroelectric par eau récupérée), Francis Babey. Electricien, vol. 51, no. 1257, Aug. 1, 1920, 10 figs. Two hydroelectric plants, at Livet and Vernes, France, successively utilize power in same water course. Article describes lower installation where 7000 hp. are developed.

The Hydroelectric Plant at Eget and Its 120–000-Volt Installations (L'usine hydroélectrique d'Eget et ses installations à 120,000 volts), Denis Eydoux and Paul Leboucher. Revue générale de l'Électricité, vol. 8, nos. 2, 3, 4 and 5, July 10, 17, 24 and 31, 1920, pp. 37–45, 75–86, 103–108 and 145–151, 50 figs. Plant comprises seven 5000-hp. turbogenerators. Height of waterfall is 2475 ft. Turbines are of horizontal Pelton type. Details of transmission line. Records of tests of turbines and alternators. (Concluded.)

Niagara Falls. Niagara Falls 100,000-Hp. Development, John L. Harper, George R. Shepard, N. R. Gibson and L. S. Bernstein. Elec. World, vol. 76, no. 12, Sept. 18, 1920, pp. 561–568, 11 figs. General engineering problems involved in development. Hydraulic design and efficiency of units and plant. Effect of loading on construction of substructures.

Queenston-Chippawa Development at Niagara Falls, Ontario, Harry Gardiner. Eng. World, vol. 15, no. 9, Nov. 1, 1919, pp. 17–21, 11 figs. Project, to cost about $25,000,000, consists of group of several parallel canals, each canal intended to develop 300,000 hp.

River-Flow Measurements. Measuring River Flow for Hydro-Electric Plant Operation, R. D. DeWolf. Power, vol. 52, no. 10, Sept. 7, 1920, pp. 361–363, 4 figs. Chart for estimating pond capacity, river flow, and period that given load can be carried with pond at given level.

Queenston-Chippawa Development. Electrical Features—Queenston-Chippawa Development, E. T. J. Brandon. Jl. Eng. Inst. of Canada, vol. 3, no. 9, Sept. 1920, p. 445. Vertical shaft generators of 45,000 kva. capacity operating at 12,000 volts, 25 cycles, $187^{1}/_{2}$ r.p.m., with thrust bearings designed to carry load of about 100,000,000 lb.

Hydraulic Installation of the Queenston-Chippawa Development, M. V. Sauer. Jl. Eng. Inst. of Canada, vol. 3, no. 9, Sept. 1920, pp. 440–444, 5 figs. Features described are canal control gate, ice chutes, screens, removable gates, penstocks, Johnson valves, turbines, governor system, control pedestals and service units.

The Design of the Queenston-Chippawa Power Canal, T. H. Hogg. Jl. Eng. Inst. of Canada, vol. 3, no. 9, Sept. 1920, pp. 435–439, 6 figs. General description of economics and hydraulics of canal, together with details of methods of design.

The General and Economic Features of the Queenston-Chippawa Development, H. G. Acres. Jl. Eng. Inst. of Canada, vol. 3, no. 9, Sept. 1920, pp. 446–452, 9 figs. Development of plant designed with aggregate of 500,000 hp. capacity.

HYDROGEN PEROXIDE

Electrolytic Production of. Electrolytic Production of Hydrogen Peroxide, F. W. Skirrow and E. R. Stein. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 10, pp. 69–79, 1 fig. Literature is briefly abstracted, followed by results of experimental decomposition of sulphuric acid, sodium or potassium acid sulphate solutions. Current efficiencies with which persulphuric acid was formed were about the same in all three solutions. Platinum was only successful anode material.

HYSTERESIS

Measurement of. Measurement of Hysteresis Values from High Magnetizing Forces, W. L. Cheney. Scientific Papers of Bur. of Standards, Dept. of Commerce, no. 383, June 19, 1920, pp. 281–289, 3 figs. Apparatus for measuring hysteresis by a modification of "isthmus method." Graphs showing coercive force and residual induction from successively higher maximum magnetizing forces plotted against latter as independent variable up to field of $H = 2500$ gausses.

I

ICE PLANTS

Atlanta, Ga. Three-Hundred-Ton Ice and Cold Storage Plant, Southern Engr., vol. 34, no. 1, Sept. 1920, pp. 58–66, 15 figs. Plant is steam driven and includes four Vilter ammonia compressors, generating units for lighting and power purposes, auxiliaries, and boiler plant rated at upwards of 1000 hp.

IGNITION

Magneto, Advantages of. Advantages of Magneto Ignition, A. D. T. Libby. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 277–287 and (discussion) pp. 287–290, 15 figs. Advantages claimed are that magneto does not depend upon battery and generator for starting and running, that with it safer starting is assured, that it gives more power with less oil and fuel, cooler and smoother-running engines and cleaner spark plugs and that it does not deteriorate rapidly with age.

INDUSTRIAL MANAGEMENT

Engineering Students, Training in. The Training of Engineering Students in Industrial Management, Bruce W. Benedict. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 492–494, 1 fig. How University of Illinois has organized its school shops upon commercial basis. Plan is based upon recognition of fact that "engineer is primarily manager of human enterprises rather than a technician making plans for others to execute."

Fixing Responsibility. Arranging Functions to Fix Responsibility, A. Whitehead. Eng., vol. 110, nos. 2849, 2850 and 2851, Aug. 6, 13 and 20, 1920, pp. 172–174, 204–206 and 236–237. Organization of shop with a view to avoiding repetition of work by various persons and establishing definite relationships between different departments.

German Engineers and. What Engineers Are Doing in Germany, E. J. Mehren. Eng. News-Rec., vol. 85, no. 12, Sept. 16, 1920, pp. 562–565. Work on standardization and progress in industrial management.

Inspection. Inspection: The Control of Quality—I, George S. Radford. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 169–172. Relation of quality to quantity, cost and marketing.

Production Systems. How Can We Increase Production? Sidney J. Williams. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, pp. 270–272. Address before Eng. Section, Nat. Safety Council.

Interdepartment Production Contest, R. R. Potter. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 258–262, 4 figs. Experience at plant of Fuller & Sons Mfg. Co., Kalamazoo, Mich.

Job Analysis Aid to Production, J. D. Hackett. Iron Trade Rev., vol. 67, no. 11, Sept. 9, 1920, pp. 722–724, 1 fig. Suggested forms of job specification to bring qualifications of worker and requirements of job together.

Shipyards. Results Obtained by Applying Scientific Management in a French Ship Yard, M. Lavallée. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 240–244, 1 fig. Results obtained in application of principles of industrial management in shipyard employing 3000 men. Translated from paper presented before Société d'Encouragement pour l'Industrie Nationale.

Store Keeping. Company Stores—Do They Pay? E. E. Adams. Iron Trade Rev., vol. 67, no. 6, Aug. 5, 1920, pp. 374–377, 4 figs. Writer believes industrial stores do not aid employers in securing labor, but he adds that as buying agencies they are justified by surprising results. Paper read before Am. Drop Forge Assn.

How Do You Regulate Materials?—III, Henry H. Farquhar. Am. Mach., vol. 53, no. 4, July 22, 1920, pp. 151–152, 1 fig. Considerations in regard to issuing goods from storeroom, and classification of materials. Principles to be kept in mind in arranging inter-relationships between various officials entrusted with maintaining material control.

Putting a Store in Your Factory, Leon I. Thomas. Factory, vol. 25, no. 5, Sept. 1, 1920, pp. 687–690. Replies from 120 plants to inquiry concerning their experience with coöperative stores.

[See also INTERCHANGEABLE MANUFACTURE; TAYLOR SYSTEM; TIME STUDY.]

INDUSTRIAL RELATIONS

Adjustment of Disputes. Adjustment of Labor Disputes in Packing House Industries. Monthly Labor Rev., vol. 11, no. 1, July 1920, pp. 101–105. From seven pamphlets issued by U. S. Administration for Adjustment of Labor Questions arising in certain packing-house industries.

Australia. Development of the Labor Situation in Australia. Monthly Labor Rev., vol. 11, no. 1, July 1920, pp. 59–66. Two systems are in operation in Australia for regulation of wages, hours and general conditions of labor; "wages board" system general aim of which is prevention of disputes by regulation of wages, hours and by special board appointed for specific industry on application or petition; and "industrial arbitration court" system, under which industry does not ordinarily come under review until dispute had actually arisen. Neither operates satisfactorily.

Employers' Association. Association Lessens Labor Difficulties, Gerard Frazar. Iron Age, vol. 106, no. 11, Sept. 9, 1920, pp. 654–657, 5 figs. Industrial situation stabilized in Hartford County, Conn., by coöperative organization of 160 manufacturers.

Justice in. Industry's One Law "Be Square with Your Men," Ernest E. Bell. Iron Trade Rev., vol. 67, no. 3, July 15, 1920, pp. 169–172 and p. 177. Emphasizes that lasting success is only attained by understanding and utilizing human element in accordance with principles of justice.

Open Shop. Detroit Vindicates Open Shop, A. J. Hain. Iron Trade Rev., vol. 67, no. 9, Aug. 26, 1920, pp. 571–574. Fourth city has attained its greatest growth under policy of freedom in industrial employment relations.

Open Shop Gaining in South, Harold F. Podhaski. Iron Trade Rev., vol. 67, no. 12, Sept. 16, 1920, pp. 787–789, 2 figs. Predicts 90 per cent of industries will soon be operating under this plan. Text of open-shop platform adopted by New Orleans Board

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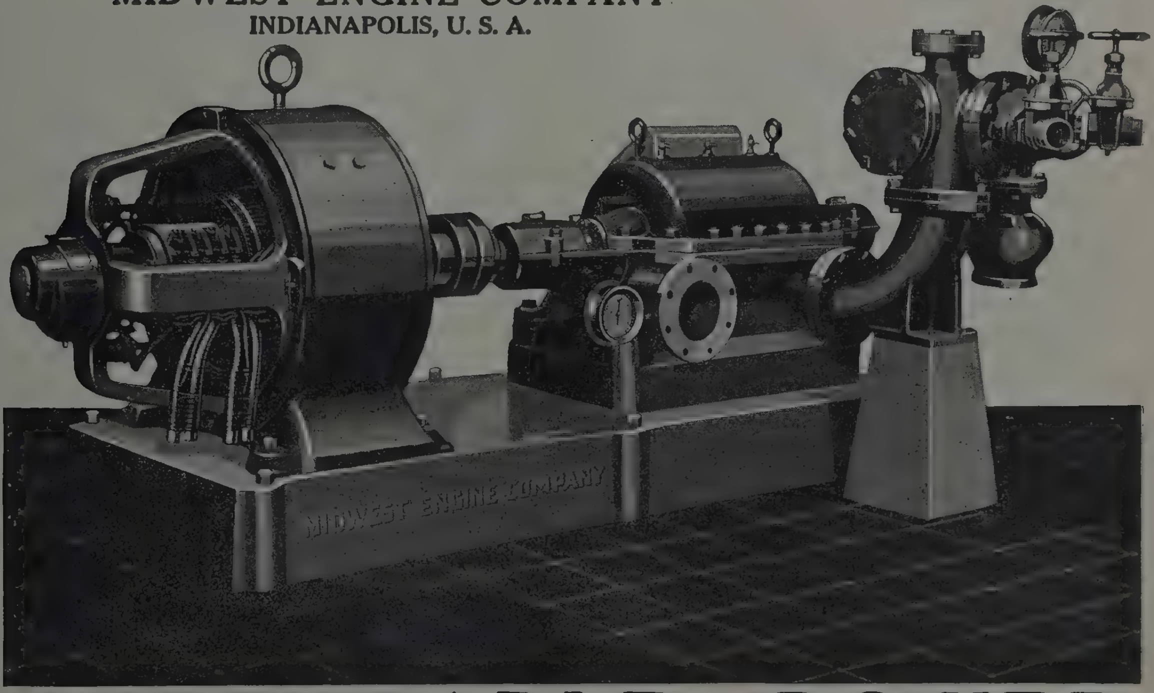

DEPENDABLE POWER

ENGINEERING INDEX (Continued)

of Trade and Association of Commerce is included.

[See also SHOP COMMITTEES.]

INFLAMMABLE MATERIALS

Liquids Storing of. A Method for Storing and Handling Inflammable Liquids (Ein neues Lager- und Förderverfahren für feuergefährliche Flüssigkeiten), Georg Urff. Automobil-Rundschau, vol. 19, no. 11–12, June 1920, pp. 113–115, 2 figs. Describes apparatus with motor-drum pump for the continuous supply of a given quantity of liquid.

INSULATORS, ELECTRIC

Suspension. The Designing and Testing of Suspension Insulators. A New Type of Insulator (Sulle caratteristiche e sulle prove degl isolatori. sospesi. Nuovo tipo di isolatore), P. G. Venturini. Elettrotecnica, vol. 7, no. 11, Apr. 15, 1920, pp. 174–178, 10 figs. Porcelain insulator developed by writer from technical study of characteristics of such insulators, and from results of experimental work. Insulator is manufactured by Società Ceramica Richard-Ginori.

INSULATORS, HEAT

Form vs. Heat Transfer. The Effect of Geometrical Form upon the Heat Transfer through Insulation, C. E. Rose. Ice & Refrigeration, vol. 59, no. 3, Sept. 1920, pp. 82–84, 4 figs. Analytical methods for computing insulation in three cases, (1) cork board on plain surface, (2) circular pipe insulated with cylinder of insulation, and (3) circular pipe enclosed in square of insulation.

INTERCHANGEABLE MANUFACTURE

Inspection and Testing. Inspection and Testing in Interchangeable Manufacture, Earle Buckingham. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 52–54. Principles involved in inspection of interchangeable parts and duties of inspection department.

[See also GAGES, Interchangeable Manufacture.]

INTERNAL-COMBUSTION ENGINES

Combustion Phenomena. Combustion Phenomena in Internal-Combustion Engines (Die Verbrennungsvorgänge im Explosionsmotor), F. Wirth. Automobil-Rundschau, vol. 19, nos. 11–12 and 13–14, June and July 1920, pp. 104–108 and 126–130. Gives formulæ and methods for calculating loss of heat in engine through exhaust gases, sensible heat of exhaust gases, etc. Notes on combustion temperature and speed; suggestions for improvements of combustion engines; bibliography. (Concluded.)

Fan Brakes for Testing. Fan Brakes for Automobile, Boat and Other Small Engines (Bremsflügel für Automobil-, Boots- und andere Kleinmotoren), Fritz Müller. Motorwagen, vol. 23, no. 12, Apr. 30, 1920, pp. 193–195, 5 figs. Describes fan brakes used during war for the quick measurement of capacity of aerial motors, pointing out that smaller brakes of same type can be used advantageously for the brake testing of automobile, boat and other small engines.

Fuel-Consumption Measurement. A New Type of Fuel- and Oil-Consumption Measurement (Eine neuartige Brennstoff- und Oelverbrauchsmessung), K. Fr. Nägele. Oel- u. Gasmaschine, vol. 17, no. 7, July 1920, pp. 99–102, 8 figs. Details of the Seppeler sampling apparatus by use of which it is possible from samples to determine quickly, simply and accurately amount of fuel consumed.

German Submarines. The Motors of the German Submarines (Les moteurs des sousmarins allemands), H. Tastet and F. Bégue. Technique Moderne, vol. 12, no. 5, May 1920, pp. 204–212, 16 figs. Characteristics: Number of cylinders, 6; dimensions of cylinders, 500 mm. stroke by 450 mm. diameter; total power 1650 hp.; total length of machine, 11 meters; width, 1.074 meters; height, 2.407 meters. Built by Germania-Krupp Works.

Low-Temperature Cycle for. A Low Temperature Cycle for Large Internal Combustion Engines, J. R. Kingston. Engr., vol. 130, no. 3372, Aug. 13, 1920, pp. 164–165, 3 figs. Suggests adopting thermodynamic cycle having adiabatic compression and expansion.

Piston Cooling. Piston Cooling for Internal-Combustion Engines (Kolbenkühlung für Verbrennungsmotoren), W. Schlachter. Schiffbau, vol. 21, no. 34, July 14, 1920, pp. 925–931, 7 figs. For a better oversight of conditions governing maintenance of permissible temperatures in pistons, the heating of piston by the burning gases and the radiation of heat from the cylinder are investigated and approximate calculations made.

Pratt. New Universal Type of Heat Engine. Can. Engr., vol. 39, no. 10, Sept. 2, 1920, pp. 310–311 and p. 313, 3 figs. Internal-combustion engine invented by G. R. Pratt of Winnipeg, Canada. Combustion takes place in chamber separate from cylinders, and displacer delivers charges of air and hot gases. Lump or powdered coal is used as fuel in a furnace or producer.

Radial. The Possibilities of the Radial Engine, J. B. Swan. Automobile Engr., vol. 11, no. 141, Aug. 1920, pp. 306–310. After viewing possibilities of radial engines, opinion is expressed that (1) as regards installation, radial engine has distinct drawbacks for all uses except tractors and aircraft, and (2) as regards manufacture, radial engine is far more expensive to produce than vertical engine, and very little cheaper than V-type.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; HEAVY-OIL ENGINES; OIL ENGINES.]

INVESTMENT

Economic Limits in. Determining Limits of Legitimate Capital Expenditure, J. R. Wade. Eng. News-Rec., vol. 85, no. 8, Aug. 19, 1920, pp. 358–359, 2 figs. Chart indicating relation of variable interest charges and operating expenses to maximum economy, constructed for determining limits of useful capital expenditure for any engineering work or program of industrial expansion.

IRON

Central Europe, Resources of. Iron in the New States of Europe, Bruno Schapira. Iron Trade Rev., vol. 67, no. 11, Sept. 9, 1920, pp. 717–720. Austria and Hungary shorn of coal and iron resources. Czecho-Slovakia heir to industrial power. How iron and steel resources of Central Europe have been rearranged by treaty.

Hydrogen Penetration of. The Penetration of Iron by Hydrogen, T. S. Fuller. Gen. Elec. Rev., vol. 23, no. 8, Aug. 1920, pp. 702–711. Results of tests made to determine effect of current, treatment of iron temperature, electrolyte, and surface coating on penetration of iron by nascent hydrogen. It was found that rate of penetration increases with increase in temperature and is greater for iron immersed in one per cent sulphuric acid than for iron-electrolyzed as cathode in similar solution. Coating iron with tin increases rate of penetration, while coating it with zinc or copper has opposite effect.

Oxygen in Determination. The Determination of Oxygen in Iron—II (Ueber die Bestimmung des Sauerstoffs im Eisen), P. Obeoffer and O. von Kiel. Stahl u. Eisen, vol. 40, no. 24, June 17, 1920, pp. 812–814, 1 fig. Results of tests before and after reduction are said to show that at higher reduction temperature (1150 deg.) more oxygen is determined than at 950 deg., but from values given, it is not evident whether total oxygen can be determined at this temperature.

IRON INDUSTRY

France. France's Iron and Steel Future, Francis Miltoun. Iron Trade Rev., vol. 67, no. 12, Sept. 16, 1920, pp. 780–786 and p. 792, 4 figs. Next to United States, France leads world in iron ore resources. Future developments of iron and steel industry in France are visualized.

IRRIGATION

Argentina. Irrigation in Mendoza, Argentina, S. T. Henry. Eng. News-Rec., vol. 85, no. 8, Aug. 19, 1920, pp. 353–355, 6 figs. Project involving irrigation of 100,000 acres.

Canal Cleaning. Removal of Vegetation from Twin Falls Irrigation Canals, R. M. Adams. Eng. News-Rec., vol. 85, no. 7, Aug. 12, 1920, pp. 319–321, 3 figs. Modified disk harrow found successful after eight years' trial of various methods and machines. Cost of operation is $24 per mile.

K

KEYS

Length of. A Chart for Lengths of Keys, John S. Watts. Am. Mach., vol. 53, no. 12, Sept. 16, 1920, pp. 560–561, 2 figs. Standard width and thickness of key is assumed for each diameter of shaft. Chart gives length of standard size key that will transmit required torque at each diameter of shaft.

L

LABOR

Hours of Work. Why It Paid Us to Adopt the Five-Day Week, Richard A. Feiss. Factory, vol. 25, no. 4, Aug. 15, 1920, pp. 523–526, 2 figs. Example of manufacturer is given who, it is said, during period of abnormal conditions, turned to plan of paying bonuses in time instead of money. It is stated that increased production resulted in 14 per cent less time.

[See also INDUSTRIAL RELATIONS; TRADE UNIONS.]

LABOR TURNOVER

Cost of. Finding Out What Turnover Costs, J. R. Sedgwick. Factory, vol. 25, no. 4, Aug. 15, 1920, pp. 530–532, 4 figs. Method is suggested for determining exact figures on cost of labor turnover.

LABORATORIES

Aerodynamic, Italy. Aerodynamic Laboratory of the Royal Polytechnic Institute of Turin, Italy (Il laboratorio di aerodinamica del R. Politecnico di Torino), Cesare Chiodi. Associazione Nazionale degli Ingegneri Italiani, Giornale Ufficiale, vol. 1, nos. 4 and 5, Feb. 10 and Feb. 20, 1920, pp. 21–25 and 29–31, 11 figs. Machinery and equipment. (To be continued.)

Ecole Supérieure d'Électricité. Annual Report on the Central Laboratory and the Ecole Supérieure d'Électricité (Rapport annuel sur le laboratoire central et l'École Superiéure d'Électricité), P. Janet. Bulletin de la Société Française des Électriciens, vol. 10, no. 88, April 1920, pp. 130–145. Researches on electricity during 1919.

[See also RESEARCH, Industrial.]

LATHES

Automatic. Some Interesting Examples of Tool Layout, J. H. Moore. Can. Machy., vol. 24, no. 9, Aug. 26, 1920, pp. 195–197, 9 figs. Tool layouts of Potter and Johnston manufacturing automatic chucking and turning machines.

Capstan. Capstan Lathe Practice—II. Machy. (Lond.), vol. 16, no. 414, Sept. 2, 1920, pp. 678–681, 11 figs. Tooling equipments used in machining castings and bar stock parts on hand screw machines.

Drummond Toolroom. A New Tool Room Lathe. Automobile Engr., vol. 11, no. 141, Aug. 1920, pp. 323–327, 14 figs. Description of Drummond 7-in.-center machine.

Turret. New Machine Tool for Railway Workshops. Ry. Engr., vol. 41, no. 488, Sept. 1920, pp. 378–379, 3 figs. Hexagon turret lathe adapted for machining of crown or roof stays.

Tooling Acme Turret Lathes. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 5–9, 12 figs. Tooling equipment for performing turret-lathe operations on friction pulleys, aluminum pistons, gear blanks and other machine parts.

LEAD PLATING

Sodium Hydroxide Lead Baths. Lead Plating from Sodium Hydroxide Lead Baths by the Use of Addition Agents, Frank C. Mathers. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 5, pp. 35–39. Gum sandarac, gum galbanum, rosin and oleic acid were satisfactory addition agents for restraining crystalline structure of cathode deposits in alkaline lead baths. Other gums, rosins and fatty acids showed marked beneficial influences.

LIGHTING

Indirect, Maintenance of Equipment. Maintenance of Indirect Lighting Equipment, J. L. Stair. Trans. Illuminating Eng. Soc., vol. 15, no. 5, July 20, 1920, pp. 292–302, 4 figs. Tests made at Chicago plant of Armour & Co. showed that deterioration due to dirt and dust settling upon lighting equipment amounts to about 10 per cent a month.

Industrial. The RLM Standard Reflector for Industrial Lighting, Ward Harrison. Trans. of Illuminating Eng. Soc., vol. 15, no. 6, Aug. 30, 1920, pp. 374–384, 11 figs. Photometric distribution curves.

Parks. Cost Problems in the Lighting of Public Parks, C. H. Shepherd. Elec. Rev., vol. 77, no. 11, Sept. 11, 1920, pp. 389–394, 8 figs. Methods used in replacement of old arc-lighting equipment with type C lamps at Lincoln Park, Chicago. Reduction in cost resulting from change.

Reflection Factor, Measurement of. A New Portable Reflectometer, A. H. Taylor. Elec. World, vol. 76, no. 10, Sept. 4, 1920, pp. 467–469, 2 figs. Device for measuring diffuse reflection factor of walls by means of portable photometer and integrating photometric sphere.

LIGNITE

Carbonization, Low-Temperature. Low-Temperature Carbonization of Low-Grade Fuels, Particularly of Lignite (Die Tieftemperaturverkohlung geringwertiger Brennstoffe, insbesondere der Braunkohle), Ernst Wolff. Braunkohle, vol. 19, no. 3, May 1, 1920, pp. 41–42. Writer tells of his experiments with the distillation of garbage at a temperature of 450 to 550 deg. cent. and of low-grade Bavarian lignite at a temperature of 370 deg. cent., whereby a high grade of gas was obtained.

Distillation of. Experiments on the Distillation of Lignites and of Mixtures of Lignite and Anthracite (Orientierende Versuche über die Entgasung von Braunkohle und Braunkohle-Steinkohle-Mischungen), A. Viehoff and E. Czakó. Jl. für Gasbeleuchtung u. Wasserversorgung, vol. 63, no. 24, June 12, 1920, pp. 279–383, 4 figs. Results of proximate analysis, calorimetric investigation and elementary analysis of four specimens of lignite, smoldering tests of three specimens of anthracite, and distillation tests of mixtures of lignite and anthracite. It is concluded that it is better to distill lignite and anthracite separately.

[See also COAL MINES, Open Pit, Lignite.]

LOCOMOTIVE BOILERS

Efficiency, British vs. American. Steam Boiler Efficiency, Jas. Dunlop. Engr., vol. 130, no. 3368, July 16, 1920, p. 60. Locomotive-boiler test results obtained in testing plant of St. Louis, Mo. Thermal efficiencies were lower than are realized in British locomotive boilers. This is explained by fact that tube diameters of British boilers are smaller than those of American boilers.

Flue-Tube Joints. Tensile Strength of Various Types of Flue-Tube Joints (Essais à la traction de joints de tuyauterie à lentille et à collarette et de joints mandrinés), M. Bonnin. Revue générale des Chemins de Fer, vol. 39, no. 6, June 1920, pp. 389–393, 6 figs. Tests conducted by Northern Ry. of France.

LOCOMOTIVES

Booster for. The Locomotive Booster, J. Snowden Bell. Ry. Rev., vol. 67, no. 11, Sept. 11, 1920, pp. 387–388, 1 fig. Appliance for temporarily increasing tractive power of locomotive by means of a pair of auxiliary steam cylinders actuating trailing truck axle. Translated from Revue générale des Chemins de Fer.

The Locomotive Booster. Ry. & Locomotive Eng., vol. 33, no. 9, Sept. 1920, pp. 266–267, 4 figs. Simple two-cylinder steam engine applied to trailing wheels at starting and when going up-hill.

British. 2–8–0 Type Superheater Locomotive for the Ministry of Munitions. Eng., vol. 110, no. 2849, Aug. 6, 1920, pp. 176–177, 7 figs. partly on supp. plate. Dimensions: cylinders, 21-in. diameter by $25\,^{3}/_{16}$-in. stroke; driving wheels, diameter, 4 ft. $6\,^{1}/_{4}$ in.; leading wheels, diameter, 3 ft. $1\,^{1}/_{2}$ in.; total heating surface, 1715 sq. ft.; superheater surface, 308 sq. ft.; working pressure 135 lb. per sq. in.; length of engine, 38 ft. $9\,^{5}/_{8}$ in.; weight of engine in working order, 71.4 tons.

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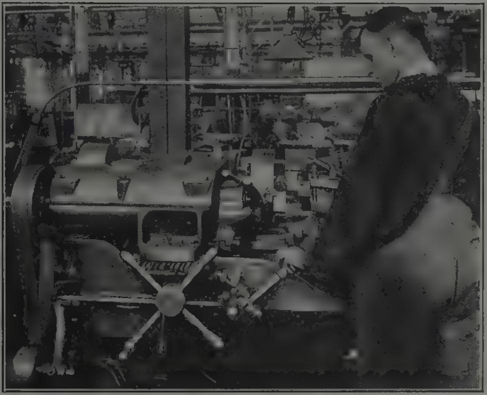
Turn down the feed lever, rotate until dial shows feed desired, and push it up again. That is all. No stopping the spindle, no stopping the feed. The cut goes right on.

The feed change is by hardened steel gears, running in oil. Just like an automobile transmission.

Feeds that feed and Stops that stop—are found in *The* Hartness Flat Turret Lathe



Jones & Lamson Machine Company

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Associated Service Bldg., 256-258 Main Street, BUFFALO, N. Y.
9-10 Water Lane, Queen Victoria St., LONDON, ENGLAND

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France, Spain and Belgium—F. Auberty & Co., 91 Rue de Maubeuge, Paris.

Holland—Spliethoff, Beeuwkes & Co., Leuvehaven, wz 159 Rotterdam.

Japan, Korea, etc.—Mitsui & Co., Ltd., Tokio.

Australasia—McPherson's Pty. Ltd., 554 Collins St., Melbourne.

SEE OUR DATA IN 1920 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

ENGINEERING INDEX (Continued)

Front-End Air Leaks. How Front-End Air Leaks Can Be Prevented. Ry. Mech. Engr., vol. 94, no. 8, Aug. 1920, pp. 515–516, 5 figs. Account of tests made by Fuel Conservation Section of Railroad Administration to determine exact effect of reducing nozzles and disarranging front end to overcome effects of front-end air leaks.

Luttermöller Radial Axles. Locomotives with Luttermöller Radial Axles (Bogenläufige Lokomotive mit Lüttermöllers Radialachsen), Heinrich Papst. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 31, July 31, 1920, pp. 599–602, 9 figs. Describes new gear-driven radial axle and demonstrates its use on light narrow-gage locomotives. Axle is equally suitable for inside and outside frames.

Valve Gears, Young. Actuating Mechanism of the Steam Locomotive. Ry. & Locomotive Eng., vol. 33, no. 9, Sept. 1920, pp. 260–263, 5 figs. Piston-type valve gear invented by O. W. Young.

Water-Indicating Devices. Improved Water Indicating Devices Necessary. Ry. Age, vol. 69, no. 9, Aug. 27, 1920, pp. 359–362, 4 figs. Account of recent government tests. It was found that gage cocks screwed directly in boiler do not correctly indicate general water level. Water column that is able to afford safest and most practical method for accurately indicating general water level in boiler under all conditions of service is worked out.

Urgent Need of Improved Water Gage Appliance. Ry. & Locomotive Eng., vol. 33, no. 9, Sept. 1920, pp. 272–278, 11 figs. Tests conducted by Bur. of Locomotive Inspection, Interstate Commerce Commission.

Works. Beardmore's Locomotive Works. Engr., vol. 130, no. 3372, Aug. 13, 1920, pp. 149–150, 11 figs. partly on 2 supp. plates. Reconstruction for locomotive manufacture of works building large gun mounting during war.

Worthington Feedwater Heater. Worthington Open Time Locomotive Feedwater Heater (Réchauffeuralimentateur pour locomotives type "Ouvert," systéme Worthington). Génie Civil, vol. 77, no. 3, July 17, 1920, pp. 51–53, 7 figs. Heater, feeder, automatic regulator of water level and two pumps, one for cold and one for hot water, operated by same steam piston, combined in one unit. Record of tests.

[See also ELECTRIC LOCOMOTIVES; MINE LOCOMOTIVES.]

M

MAGNETOS

Ignition. A Gaging Fixture for the Relation of the Cams to Keyway. Automotive Industries, vol. 43, no. 10, Sept. 2, 1920, p. 257, 1 fig. Device for measuring angular relation of breaking point on cam and keyway on shaft of ignition magnetos.

MACHINE CONSTRUCTION

Substitute Materials. Recent Experiences and Experiments with Substitute Materials in the Construction and Operation of Machines (Mitteilungen über neuere Erfahrungen und Versuche mit Ersatzstoffen im Bau und Betrieb von Maschinen), G. v. Hanffstengel. Annalen für Gewerbe u. Bauwesen, vol. 86, no. 7, Apr. 1, 1920, pp. 49–57, 22 figs. Address read before Assn. German Machine Engineers in Feb. 1917, but withheld from publication during war.

MACHINE SHOPS

College. The Loughborough Technical College. Eng., vol. 110, nos. 2850 and 2851, Aug. 13 and 20, 1920, pp. 199–202, 19 figs. partly on 2 supp. plates, and 232–236, 12 figs. Instructional factory organized throughout as far as possible as commercial firm.

MACHINE-TOOL INDUSTRY

Automobile Factories. Labour-Saving Devices in a Motor Car Works. Engr., vol. 130, no. 3373, Aug. 20, 1920, pp. 132–133 and p. 136, 9 figs. Machine tools at works of Vulcan Motor and Engineering Co., Ltd., Crossens, Southport, England.

British. The British Machine Tool Industry. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, pp. 23–24. Industry is rapidly reaching more normal conditions although it is not quite up to pre-war standards. New developments are being constantly introduced. Concentration on minimum of varieties is being substituted for pre-war tendencies on part of many firms to undertake any type of tool for which inquiry was received.

German. The German Machine Tool Industry. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, p. 21. Output since 1914 has increased considerably, and export of twist drills and other metal-working tools as well as of precision measuring instruments assumed large proportions during past year.

International Exposition. The Machine Tool and Engineering Exhibition. Eng. Production, vol. 1, no 9, Sept. 1920, pp. 324–354, 58 figs. Models exhibited.

The Second International Machine Tool and Engineering Exhibition. Machy. (Lond.), vol. 16, nos. 413 and 414, Aug. 26 and Sept. 2, 1920, pp. 655–661 and 687–694, 12 figs. Review of exhibits, including Smith & Coventry spiral-bevel-gear planer; Archdale automatic manufacturing milling machine; Herbert 4-ft. radial drilling machine; Asquith universal portable radial drilling machine.

MACHINERY

Foundations. New Process of Fixing a Machine on Its Concrete Foundation (Un nouveau procédé de fixation sur les maconneries), Ouvrier Moderne, vol. 3, no. 1, April 1920, pp. 18–20, 11 figs. Bolt with cylindrical elements which press against sides of hole in masonry as nut fastening the machine is driven on bolt.

MALLEABLE IRON

Grain of. The Fine Structure of Malleable Iron in Connection with Its Tensile-Strength Properties (Ueber das Kleingefüge des Tempergusses in Zusammenhang mit seinen Festigkeitseigenschaften), Rudolf Stotz. Stahl u. Eisen, vol. 40, no. 30, July 29, 1920, pp. 997–1002, 42 figs. 36 on 3 supp. plates. Discussion with the aid of photographs of the fine grain of high- and low-grade malleable iron and foundry pig iron, and especially of the production of the skin by annealing. Results of investigations carried out in the material-testing department of the A. Stotz Corp., Stuttgart-Kornwestheim.

Properties. Variables Bias Malleable Tests, H. A. Schwartz. Iron Trade Rev. vol. 67, no. 6, Aug. 5, 1920, pp. 371–373, 5 figs. Relation between tensile strength and percentage of elongation and diameter of rough and machined specimens is shown in graphically expressed data. Paper read before Am. Soc. for Testing Materials.

MANAGEMENT

Statistics, Value of. Commercial Statistics and Their Value to the Executive, G. P. Baldwin. Gen. Elec. Rev., vol. 23, no. 8, Aug. 1920, pp. 648–652, 7 figs. Graphical methods are suggested for preparing statistics for number of orders taken, amount of sales made, and expense incurred by sales office.

MARINE ENGINES

See DIESEL ENGINES.

MARINE STEAM TURBINES

Reduction-Geared. Geared Turbines with Double Reduction Gear. Eng., vol. 110, no. 2850, Aug. 13, 1920, pp. 211–212 and p. 214, 9 figs. partly on 2 supp. plates. Turbines are designed to develop aggregate of 3000 hp. Three are ahead turbines arranged in series and two astern turbines fitted, respectively, within low-pressure and intermediate pressure casings. High-pressure and intermediate turbines both gear with one wheel. Low-pressure gears with second wheel on opposite side of propeller shaft. Installation was constructed by the Parsons Marine Steam Turbine Co., Ltd., for S. S. "Corrientes."

Vibration in. Vibration in Ship Turbines (Schwingungen bei Schiffsturbinen), H. Hülcker. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 31, July 31, 1920, pp. 603–605, 4 figs. Frequent turbine disturbances which occurred on a torpedo boat could only be attributed to vibrations of the turbine rotor. Investigation by means of pallographs could not be completed. Opinions of several authorities in regard to case are recorded.

[See also REDUCTION GEARS.]

MATERIALS

Properties at High Temperatures. The Effect of Temperature on Some of the Properties of Materials, F. C. Lea. Eng., vol. 110, no. 2852, Aug. 27, 1920, pp. 293–298, 31 figs. Results of experiments with aluminum alloys, alloy steels, and concrete cylinders. It was found, for example, for mild steel that maximum strength is passed at 235 deg. cent. At temperatures beyond 300 deg. cent. strength diminished very rapidly and at temperatures from 615 to 640 deg. cent. breaking strength was less than 7 tons per sq. in. Paper read before Eng. Section, British Assn. for Advancement of Science.

Repeated-Stress Safety Factors. Repeated-Stress Safety Factors Quickly Determined, J. B. Kommers. Eng. News-Rec., vol. 85, no. 9, Aug. 26, 1920, pp. 393–394. Table of factors based on unit stress and on repetition. Goodman's diagram and recent test data used.

Strength and Suitability. The Strength and Suitability of Engineering Materials, C. F. Jenkin. Engr., vol. 130, no. 3374, Aug. 27, 1920, pp. 200–201. Presidential address to Eng. Section, British Assn. for Advancement of Science.

MEASURING MACHINES

Modulimeter. The Widney Modulimeter. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 254–256, 2 figs. Machine for measuring recoverance of material. Recoverance is "capacity of material to return immediately the energy that has been imparted to it by any external force."

METAL SPRAYING

Schoop Process. The Schoop Metal-Spraying Process and Its Prospects (Das Metallspritzverfahren nach Schoop und seine Aussichten), Robert Hopfelt. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 30, July 24, 1920, pp. 578–579. According to experiments made with process up to present time, tin-spraying cannot be recommended, whereas with zinc and lead good results have been obtained. Metal coating of wood, paper and textiles has not proved advantageous.

METALLOGRAPHY

Non-Ferrous Castings. Metallography in the Detection of a Substituted Test Coupon, D. J. McAdam, Jr., and Gilbert E. Doan. Jl. Am. Soc. Naval Engrs., vol. 32, no. 3, Aug. 1920, pp. 481–487, 13 figs. Experience in application of metallography to inspection of non-ferrous castings. It was desired to determine history of castings by metallographic analysis.

METALS

Rigidity of. Note on the Influence of Temperature on the Rigidity of Metals, A. Mallock. Proc. of Roy. Soc., vol. 97, no. 687a, Aug. 3, 1920, pp. 450–455, 2 figs. Experiments showed that the more fusible the metal the less is rigidity affected by change of temperature.

METEOROLOGY

Kite Balloon. An Improved A. P. Kite Balloon, J. F. Boyle. Aviation, vol. 9, no. 3, Sept. 1, 1920, pp. 89–91, 2 figs. Gas bag is nearly spherical in shape. Ballonet is forward and is similar to Caquot ballonet. Mooring band is catenary type, with 15 mooring points. Rip panel is in shape of inverted V and straddles nose of gas bag.

METRIC SYSTEM

Arguments against Adoption in U. S. Report of the Cleveland Chamber of Commerce on the Metric System. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, pp. 283–287, 1 fig. Committee "is not able to believe that the adoption of the metric system will promote....standards and interchangeability."

The Metric System, Attitude of the Westinghouse Company, M. C. Turpin. Ry. Rev., vol. 67, no. 9, Aug. 28, 1920, pp. 316–319. Reasons why Westinghouse Electric & Manufacturing Co. is opposing introduction of metric system in America. Writer is assistant to manager of department of publicity of Westinghouse Company.

Why the Westinghouse Company Does Not Use the Metric System. Machy. (N. Y.), vol. 27, no. 1, Sept. 1920, p. 22. Metric measurements are claimed to complicate shop work because they cannot, as English, be halved and quartered without introducing complicating fractions.

MICROPHOTOMETERS

New Type. A New Microphotometer for Photographic Densities, W. F. Meggers and Paul D. Foote. Scientific Papers of Bur. of Standards, Dept. of Commerce, no. 385, June 30, 1920, pp. 299–308, 6 figs. Instrument is essentially micropyrometer described in bul. 4 of Bur. of Standards, vol. 9, 1913, p. 475, except that microscope of higher power is used.

MILLING MACHINES

Crankshaft. Stamets Crankshaft Milling Machine, Ethan Vial. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, pp. 245–248, 7 figs. Construction and operation of machines for quantity milling of odd-shaped crankshaft.

Parkinson. Recent Machine Tool Developments—XV, Joseph Horner. Eng., vol. 110, no. 2852, Aug. 27, 1920, pp. 268–270, 9 figs. Parkinson universal milling machines. (Continuation of serial.)

MINE HAULAGE

Acceleration, Measurement of. Measurement of Acceleration of Haulage Plants (Zur Messung der Beschleunigung auf Förderanlagen), E. Jahnke and G. Keinath. Dingler's polytechnisches Jl., vol. 305, no. 11, May 29, 1920, pp. 119–125, 16 figs. Results of experiments carried out in haulage plants of a number of mines with a described registering acceleration meter constructed by Siemens & Halske.

MINE HOISTING

Duty Cycles. Mine-Hoisting Duty Cycles in Practical Operation, M. A. Whiting. Proc. Engrs. Soc. Western Pa., vol. 36, no. 5, June 1920, pp. 345–365 and (discussion), pp. 366–380, 7 figs. Differences between calculations and practice are pointed out with reference to actual installation.

MINE LOCOMOTIVES

Development. Developments in Locomotive Construction, H. H. Johnston. Coal Industry, vol. 3, no. 9, Sept. 1920, pp. 428–431, 3 figs. Improvement in control, contactors and contactor compartments, reversers, overload protection, grid resistors, headlights and gears.

Flooded, Drying Out. How Electrical Apparatus Was Restored after Being Deeply Submerged, E. J. Gealy. Coal Age, vol. 18, no. 11, Sept. 9, 1920, pp. 540–541, 1 fig. Mine flood covered locomotives of Sayre Colliery under head of about 30 ft. Apparatus thus drowned was dried in temporary oven and put back into service, saving both time and money.

MINE TIMBERING

Methods. Timbering in Mines, Gomer Edwards. Iron & Coal Trades Rev., vol. 101, no. 2735, July 30, 1920, pp. 134–136, 32 figs. Comparative study of timbering methods. Writer declares himself in favor of timber at faces, combination of timber and masonry or timber and iron on branch roads, and masonry only or masonry and metal on main roads and pit bottom.

MINERALS

Vonsenite. Vonsenite. A Preliminary Note on a New Mineral, Arthur S. Eakle. Am. Mineralogist, vol. 5, no. 8, Aug. 1920, pp. 141–143. Specimens of coal-black, lustrous mineral collected at Riverside, Cal., by M. Vonsen.

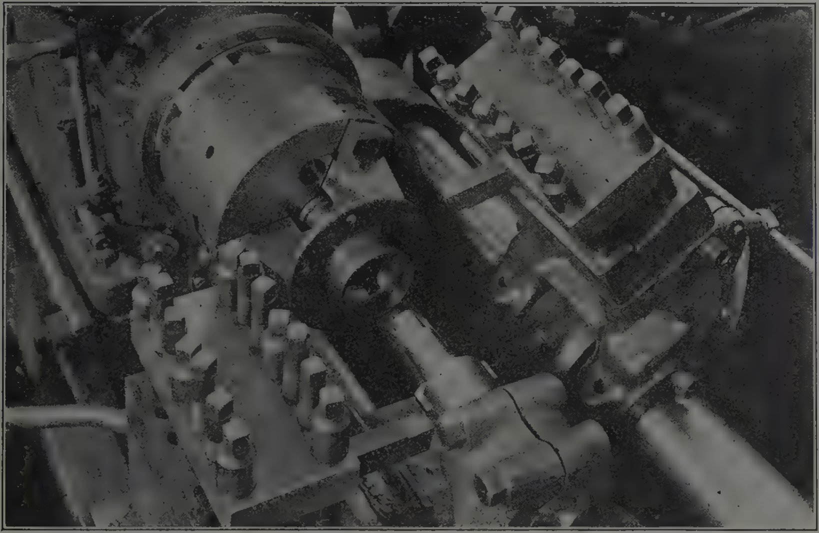
MINERS' LAMPS

Electric. The "Oldham" Patent Cap Type Miner's Electric Safety-Lamp, George Oldham. Trans. of Instn. Min. Engrs., vol. 59, part 4, Aug. 1920, pp. 334–337 and (discussion), pp. 337–348, 3 figs. Storage battery is carried on belt and lamp attached to cap.

Singing-Flame Firedamp. The Fleissner Singing-Flame Lamp, William Maurice. Trans. of Instn. of Min. Engrs., vol. 59, part 4, Aug. 1920, pp. 311–321, 8 figs. Pitch of sound given by singing flame is increased when firedamp enters into tube. Record of experiments and description of lamp.

The FAY WAY *of*

Machining an Automobile Hub



The above photograph shows the method of boring and facing an automobile hub on the Fay Automatic Lathe.

A special boring attachment is clamped to the center bar. The fixture is held in position by arms resting and riding on the machine ways.

The back arm rocks in and faces.

The front carriage rocks in and chamfers.

One man runs two machines.

A fast operation on a swift, accurate machine, at a low labor cost.

One operator running 1st and 2nd operations
completes 45 Hubs per hour

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Japan, Korea, etc.—Mitsui & Co., Ltd., Tokio

Australasia—McPherson's Pty. Ltd., 554 Collins St., Melbourne

SEE OUR DATA IN 1920 ASME CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

ENGINEERING INDEX (Continued)

MINES

Rescue Apparatus. Mine Rescue Apparatus. Iron & Coal Trades Rev., vol. 101, nos. 2735 and 2736, July 30 and Aug. 6, 1920, pp. 129–131 and 161–164, 15 figs. Report issued by Mine Rescue Apparatus Research Committee appointed by Advisory Council for Scientific and Industrial Research, England. Account is given of experimental results obtained in Edinburgh during last two years, and new or improved methods and apparatus which are outcome of such investigation are described.

The Mine Rescue Apparatus Research Committee. Colliery Guardian, vol. 120, nos. 3110, 3111 and 3112, Aug. 6, 13 and 20, 1920, pp. 379–381, 449–450 and 522–524, 17 figs. Warning against use of certain appliances for mining purposes. Construction, operation and record of tests of Briggs compressed oxygen mine-rescue apparatus. (Concluded.)

Shaft Lining. Concreting the Chief Consolidated Shaft at Eureka, Utah, R. D. Gardner. Eng. & Min. Jl., vol. 110, no. 10, Sept. 4, 1920, pp. 460–462, 3 figs. Work of lining was carried on simultaneously with sinking and was done in stages of 50 to 60 ft., according to nature of ground. Average advance, 61 ft. per month. Precast dividers used.

Signaling. Designing Mine Signal Systems, R. H. Bacon. Elec. World, vol. 76, no. 8, Aug. 21, 1920, pp. 372–375, 4 figs. Design of systems. Operating factors that affect selection of circuit layout in deep-shaft metal mines. Costs of modern system for 3000-ft. shaft.

Stench Warnings. Stench Warnings in Metal Mines, A. C. Fieldner and S. H. Katz. Reports of Investigations, Bur. of Mines, serial no. 2153, Aug. 1920, 3 pp. Investigations are said to have demonstrated that warnings which are perceived by miners through sense of smell are "exceedingly simple to install and are on the whole as effective as any other system heretofore used."

MINING

Costs. The Cost of Mining as Influenced by Poor Development, A. G. Wolf. Eng. & Min. Jl., vol. 110, no. 12, Sept. 18, 1920, pp. 565–566. Money and time loss through unnecessary footage of drifts and cross-cuts illustrated by concrete example.

Sweden. Swedish Minerals and the Metallurgical Industry in Germany during the War (Les minerals suedois et l'industrie sidérurgique allemande pendant la guerre), Paul Nicou. Annales des Mines, vol. 9, no. 6, 1920, pp. 339–487. Part played by Sweden in supplying Germany with metals, particularly during the war. Statistics of Swedish metal production, and description of operation of some of large iron mines during the war years; also, of Baltic ports, whence minerals were exported to German coast towns.

MINING INDUSTRY

British Act. Mining Industry Act, 1920. Colliery Guardian, vol. 120, no. 3113, Aug. 27, 1920, pp. 589–591. Text of act "to provide for the better administration of mines, and to regulate the coal industry, and for other purposes connected with the mining industry and the persons employed therein."

MINING, MILITARY

Tunneling. Tunneling in the Sand Dunes of the Belgian Coast, H. Tatham. Eng., vol. 110, no. 2849, Aug. 6, 1920, pp. 178–179, 8 figs. Work done by tunneling companies. It consisted (1) of wells, (2) dugouts, and (3) sinking elephant shelters

MOLYBDENUM

Determination of. Determination of Molybdenum, J. P. Bonardi and Edward P. Barrett. Dept. of Interior, Bur. of Mines, technical paper 230, 1920, 35 pp. Results of work done by Bureau of Mines in coöperation with College of Mines, University of Washington, and Colorado School of Mines. Volumetric and gravimetric methods were compared experimentally.

MORTARS

Plasticity and Measurement of. Measurement of Plasticity of Mortars and Plasters, Warren E. Emley. Technologic Papers of Bur. of Standards, Dept. of Commerce, no. 169, June 28, 1920, 27 pp., 8 figs. Plasticity of mortars is defined as ability to retain water against suction of surface to which mortar is applied and readiness to spread over the surface. Instrument for measuring plasticity so designed is described.

MOTION-PICTURE PHOTOGRAPHY

Ultra-Rapid. Chronophotography of Projectiles at the Rate of 15,000 to 20,000 Images per Second (Chronophotographie des projectiles à raison de 15,000 à 20,000 images par seconde), Jacques Boyer. Nature (Paris), no. 2411, June 19, 1920, pp. 337–341, 8 figs. Bull electric apparatus.

MOTION PICTURES

Cinema Outfits, Portable. Recent Developments in Types of Portable Cinema Outfits, J. W. Barber. Illuminating Engr., vol. 13, no. 6, June 1920, pp. 179–183 and (discussion) pp. 184–188. References are specially made to cinemotors used extensively during war by British Ministry of Information and Nat. Aims Committee, and pathescope, which with its 6-watt lamp projects picture 4 ft. in width, approximating 12 sq. ft.

Eyestrain. Interim Report of the Joint Committee Appointed by the Illuminating Engineering Society to Inquire into "Eyestrain in Cinemas." Illuminating Engr., vol. 13, no. 6, June 1920, pp. 189–193. Committee recommends that angle of elevation, subtended at eye of any person seated in front row by length of vertical line dropped from center of top edge of picture to horizontal plane passing through observer's eye shall not exceed 35 deg., height of eye above floor level being assumed to be 3 ft. 6 in., and that angle between vertical plane containing upper edge of picture, and vertical plane containing observer's eye and remote end of upper edge of picture should not be less than 25 deg.

MOTOR PLOWS

German Types. The Latest Types of German Motor Plows (Deutsche Motorpflüge in ihrer neuesten Bauart), H. Poland. Allgemeine Automobil-Zeitung, vol. 21, nos. 23 and 24, June 5 and 12, 1920, pp. 25–28 and 17–24, 14 figs. Description of new types of semi-rigid motor plows, tractors and cable plows.

Tests. Foreign Motor Plow Construction in the Light of Comparative Tests Carried out at Säbyholm, Denmark [Studien über den Motorpflugbau im Ausland bei der Vergleichsprüfung in Säbyholm (Dänemark)], W. Kaul and O. Vorbach. Motorwagen, vol. 23, nos. 15, 16 and 17, May 31, June 10 and 20, 1920, pp. 254–264, 273–281 and 295–304, 59 figs. Describes Danish method of testing and gives details of American and other models tested with tabulated results of tests.

MOTOR TRUCKS

Engine Tests. Report on Engine Tests at the Summer Meeting. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 228–231, 9 figs. Tests were run to bring out (1) decrease in brake mean effective pressure and horsepower with hot-spot manifold, (2) brake economy with hot-spot manifold at full load and at half load with same speeds, (3) flexibility and acceleration of hot spot, and (4) exhaust and intake temperature changes with variations in load and speed.

Gasoline-Electric. The Most Important Features of Modern Electric Automobile Construction (Das Wichtigste über den neuzeitlichen Elektromobilbau), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 37, no. 51–52, Mar. 31, 1920, pp. 227–228, 2 figs. Details of the Hansa-Lloyd 5-ton truck with single motor, the NAG truck with two motors, the Electro-Daimler fire trucks of the Berlin Fire Department, etc. Examples of gasoline-electric motor trucks.

Specifications. Internal-Combustion Truck Specifications. Power Wagen, vol. 24, no. 190, Sept. 1920, pp. 30–47. Table giving dimensions of engine, make of carburetor, kind of transmission, and other particulars of 570 types.

Trailers. Trailers Facilitate Heavy Haulage, Donald McLeod Lay. Iron Age, vol. 106, no. 6, Aug. 5, 1920, pp. 311–314, 5 figs. Among advantages of trailers for transporting long girders and beams are quoted better distribution of loads with less road wear and lower operation costs.

Wheels. A New Road Wheel. Motor Traction, vol. 31, no. 811, Sept. 13, 1920, p. 261, 4 figs. Patented Pickering wheel. Two rows of spokes are employed, and these are staggered or arranged so that spokes of row on one side alternate with those of other. By tightening action of flanges spokes tend to get forced toward center and are expanded circumferentially outward.

MOTORSHIPS

Concrete. World's Largest Concrete Motorship. Motorship, vol. 5, no. 9, Sept. 1920, pp. 800–801. "Cochinchine," propelled by Diesel engines. Dimensions: Deadweight capacity, 2200 tons; length overall, 228 ft.; breadth, moulded, 38 ft.; draft, loaded, 18 ft. 9 in.; power, 1280 i.hp.; trial speed, $10^{1}/_{2}$ knots.

Standardization. Motorships Being Standardized in Europe. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 757–758, 2 figs. Vessels of standard types nearing completion in Denmark and Sweden.

Steamships vs. Motorships vs. Steamships. Motorship, vol. 5, no. 9, Sept. 1920, pp. 819–823. Comparative operating expenses and earnings of cargo vessels. (To be continued.)

Zoppot. Biggest Motorship in the World Arrives at New York. Motorship, vol. 5, no. 9, Sept. 1920, pp. 796–799. Krupp-built 17,000 tons d. w. c. Diesel-driven tanker. Dimensions: Length between perpendiculars, 525 ft.; draught, 27 ft. 9 in.; power, 4000 i.hp.; screw, twin type of engine; two-cycle; speed, loaded, $11^{1}/_{2}$ knots; daily fuel consumption, 12 to 13 tons.

[See also SHIPS, Cargo Motorships vs. Steamships.]

N

NAPHTHALENE

Manufacture. Modern Technique of the Coal Tar Industry (La technique moderne de l'industrie des goudrons de houille), M. C. Berthelot. Revue de Métallurgie, vol. 17, no. 5, May 1920, pp. 335–350, 6 figs. Manufacture of pure naphthalene and anthracene. (Concluded.)

NATIONAL DEFENSE

United States. The United States in the Next War, Johnson Hagood. Jl. U. S. Artillery, vol. 53, no. 1, July 1920, pp. 1–8. Experience of war is believed to emphasize that best policy for national defense for United States lies in a strong navy with principal harbors strongly fortified.

NATURAL GAS

Gasoline Content. Factors in Determining the Gasoline Content in Natural Gas by the Absorption Method, D. B. Dow. Reports of Investigations, Bur. of Mines, serial no. 2157, Aug. 1920, 9 pp. 4 figs. Factors which should be considered in making absorption tests using "mineral seal oil" as absorbent.

NAVIGATION

Shoal-Water Warning. The Sperry Ship's Log, R. E. Kortepeter. Sperryscope, vol. 1, no. 12, Apr. 1920, pp 1–4 and 15, 7 figs. Speed and distance indicating instrument that gives shoal-water warning.

[See also SUBMARINE SIGNALS.]

NICKEL ALLOYS

Copper-Nickel, Magnetic Properties. The Magnetic Properties of Nickel-Copper Alloys (Die magnetischen Eigenschaften von Nickel-Kupfer-Legierungen), R. Gans and A. Fonseca. Annalen der Physik, vol. 61, no. 8, May 4, 1920, pp. 742–752, 5 figs. In opposition to the Tammann rule, it is concluded that ferromagnetic crystals dissolved in unmagnetic crystals can form ferromagnetic alloys. Results obtained coincide with the behavior of the Co-Cu alloys with single exception that the break in the series of the mixed crystals is considerably greater in these. Report from Physical Inst. of La Plata, Argentine.

NICKEL PLATING

See ALUMINUM, Nickel Plating.

NON-FERROUS METALS

Researches. A Study of Researches into Metallic Alloys, C. T. Heycock. Chem. Age (Lond.), vol. 3, no. 63, Aug. 28, 1920, pp. 229–232. Also in Nature (Lond.), vol. 106, no. 2654, Sept. 9, 1920, pp. 60–62. Presidential address in Chemical Section, British Association for Advancement of Science.

NOZZLES

Tests. The Use of Nozzles for Power Purposes (Ueber die Verwendung von Düsen zur Arbeitsleistung), Robert Gsell. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, No. 11, June 15, 1920, pp. 159–162, 6 figs. Suggests that for special purposes, such as filling gasoline tanks of aeroplanes, venturi tubes can be used; for more general use the ordinary nozzles cannot be employed because of too low efficiency. Charts showing results of nozzle tests.

NUTS

Manufacture. Making 30,000 Nuts in 9 Hours on One Machine, J. H. Moore. Can. Machy., vol. 24, no. 11, Sept. 9, 1920, pp. 243–245, 5 figs. Nut and Bolt Dept. of plant of International Harvester Co., Ltd., Hamilton, Canada.

O

OFFICES

Equipment. Getting the Office Work Done—III, Wallace Clark. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 189–194, 4 figs. Suggestions in regard to furnishing and equipping an office.

OIL ENGINES

Air Injection for. Air-Injection for High-Pressure Oil-Engines—III, J. L. Chaloner. Motorship, vol. 5, no. 9, Sept. 1920, pp. 806–810, 11 figs. Records of ratio of fuel to injection-air obtained in tests on a number of four-stroke engines of varying power.

Combustion Phenomena. The Combustion Phenomenon in the Oil Engine (Der Verbrennungsvorgang in der Oelmaschine), Otto Alt. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 33, Aug. 14, 1920, pp. 637–643, 13 figs. Discussion of modern spraying process of Vickers and Steinbecker without compressed air, evaporation or pyrogenous decomposition of the different fuels; influence of compression on automatic ignition. Investigation demonstrates that the expensive experimental work of oil-engine firms cannot yet be dispensed with, and chemical and technical coöperation is absolutely essential in the interest of progress.

High-Compression. The High Compression Oil Engine, J. L. Chaloner. Gas & Oil Power, vol. 15, no. 180, Sept. 2, 1920, pp. 193–198, 11 figs. Steinbecker four-stroke type.

OIL FUEL

Burning of. The Science of Burning Liquid Fuel, W. N. Best. Am. Drop Forger, vol. 6, no 8, Aug. 1920, pp. 368–373, 7 figs. Data obtained from tests covering 33 years experience in burning of different fuels in various types of furnaces.

Kermode's Pressure-Jet System. Self-Contained Pressure-Jet Oil Fuel Plant. Eng., vol. 110, no. 2849, Aug. 6, 1920, pp. 180–181, 5 figs. Kermode's pressure-jet oil fuel system. Oil is atomized in special burner which uses neither steam nor pressure air, but to which oil is supplied under pressure. Various ships have been fitted with this type of plant.

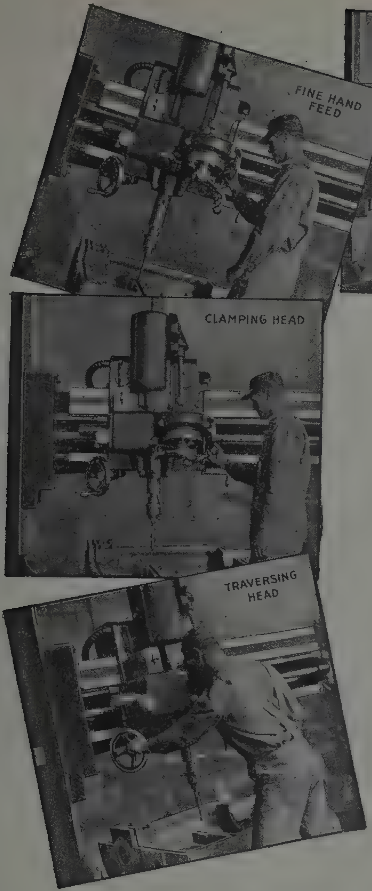
[See also FUELS, Coal vs. Oil; Liquid.]

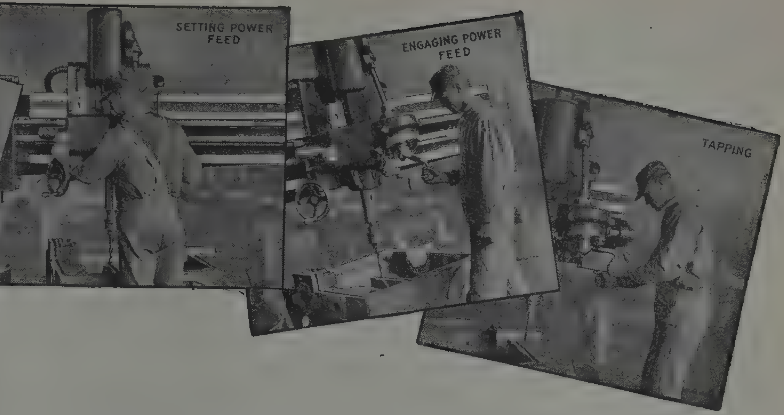
OIL INDUSTRY

Conditions in 1920. The Trend of the Oil Industry during First Half of 1920, Joseph E. Pogue. Automotive Industries, vol. 43, no. 10, Sept. 2, 1920, pp. 451–456, 4 figs. Review as to stocks, exports and production compared with conditions in 1919.

OILS

Mineral, Specific Heats. The Determination of the Specific Heat of Heavy Mineral Oils, Herbert S. Bailey and Carlton B. Edwards. Jl. Indus, & Eng. Chem., vol. 12, no. 9, Sept. 1920, pp. 891–894 1 fig. Method is outlined which is believed to be especially adaptable to plant control work and to





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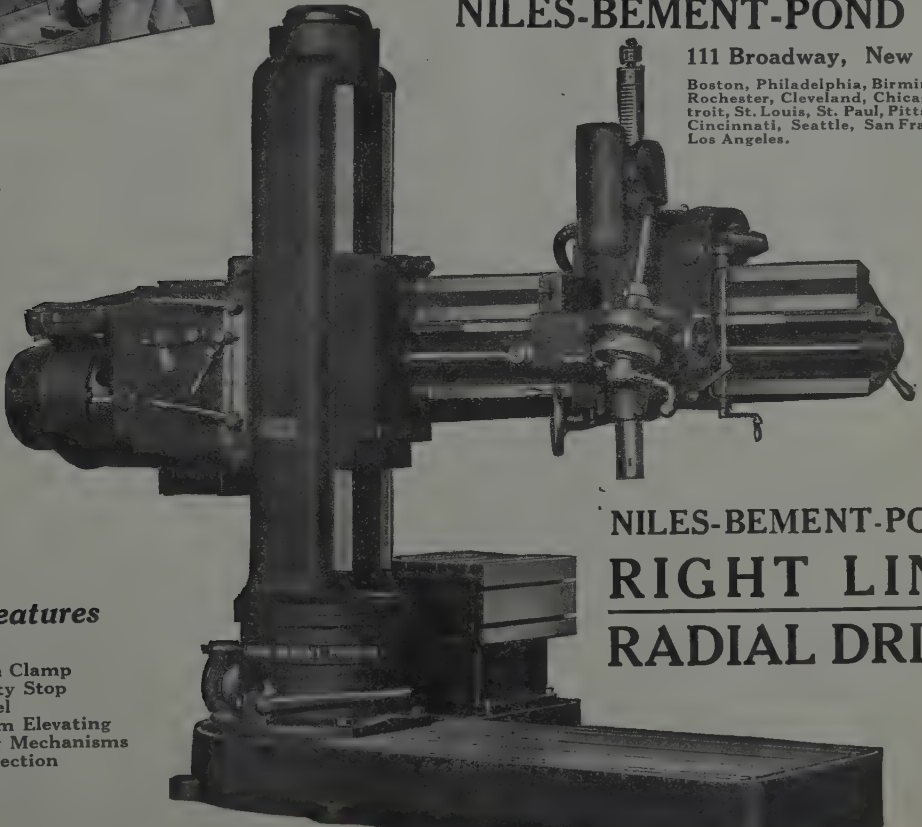

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ENGINEERING INDEX (Continued)

laboratory investigations where rapid work and fair degree of accuracy are required.

OPEN-HEARTH FURNACES

Design. Design of Open-Hearth Furnaces, A. D. Williams. Iron Age, vol. 105, no. 18 and vol. 106, no. 6, Apr. 29 and Aug. 5, 1920, pp. 1225–1226 and 319–321, 3 figs. Apr. 29. Heat-capacity curves of producer gas, various air supplies and their products of combustion, together with curves indicating calorific intensity as affected by various degrees of preheating of air, gas, and of both air and gas. Aug. 5. Waste heat boiler installations. Calculations involved and questions of setting and draft. Records of tests.

OPTOPHONE

Reading by Sound. The Optophone. Elecn., vol. 85, no. 2204, Aug. 13, 1920, pp. 183–184, 2 figs. Apparatus for reading by sound. Light from lamp placed behind rotating disk perforated with small holes in concentric circles falls on printed letter and is reflected on to selenium bridge. Light falling on letter forms five spots in line. Part of light reflected to selenium varies with shape of letter. Light impulses received at selenium bridge originate sound pulsations in telephone receiver connected in series with bridge.

ORE BINS

See CHUTES, Design.

ORE HANDLING

Automatic Unloader. Improvements in Bulk Cargo Handling. Iron Age, vol. 106, no. 7, Aug. 12, 1920, pp. 385–387, 3 figs. Fifteen-ton bucket automatic ore unloader and 100-ton car dumper for Atlantic Coast.

OSCILLATIONS

Electromagnetic. A Method of Amplifying Electrical Variations of Low Frequency, W. H. Eccles and F. S. Jordan. Elecn., vol. 85, no. 2204, Aug. 13, 1920, p. 176, 4 figs. Method consists of impressing upon a source of oscillations at frequency of amplifier the lower frequency fluctuations to be magnified, and then passing the modulated carrier oscillations through the amplifier, which magnifies them as modulated.

On the Propagation of Maintained Electrical Oscillations in Water, and the Dielectric Constant of Water (Sur la propagation dans l'eau d'oscillations électriques entretenues, et sur la constants diélectrique de l'eau), M. Sauzin. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 3, July 19, 1920, pp. 164–167. Determination of dielectric constant of water by means of phenomena produced by electrical oscillations maintained by three-electrode valve. Value found for dielectric constant of distilled water was 73.

OXY-ACETYLENE WELDING

Accident Prevention. Hazards in Gas Welding and Cutting. Power Plant Eng., vol. 24, no. 18, Sept. 15, 1920, pp. 892–895, 4 figs. Prepared by Eng. Dept. of Nat. Safety Council.

Cast Iron. Gas Welding of Cast Iron, C. K. Bryce. Welding Engr., vol. 5, no. 8, Aug. 1920, pp. 25–27. Precautions to be taken for securing good welds. Paper read before American Welding Society.

OXYGEN

Uses in Chemical and Metallurgical Industry. The Separation of Air into Oxygen and Nitrogen, Fred E. Norton. Chem. & Metallurgical Eng., vol. 23, no. 11, Sept. 15, 1920, pp. 511–518, 4 figs. States that use of oxygen in chemical and metallurgical industry is retarded by inefficiency of existing systems for air separation. Jeffries-Norton system for air separation is described, which is an extension of Carnot theorem, but using adiabatic constant-pressure lines instead of adiabatic-isothermal cycle of Carnot.

P

PAPER

Thread, Manufacture of. Manufacture of Paper Threads, J. G. Varlot. Paper, vol. 26, no. 26, Sept. 1, 1920, pp. 15–18 and p. 29, 5 figs. Machines developed in Europe, principally Germany. Translated from La Papeterie.

Manufacture of Paper Threads and Articles Made of Paper Thread (Fabrication des fils de papier et des produits en fil de papier), J. Dantzer. Technique Moderne, vol. 12, no. 5, May 1920, pp. 215–221, 21 figs. Machines employed for twisting thread. (Concluded.)

PAPER MANUFACTURE

Bleach Consumption. Curtailing Bleach Consumption by Adding Sulphur to Digested Liquor, George K. Spence. Paper, vol. 26, no. 27, Sept. 8, 1920, pp. 19–21. Tables giving results of experiments performed with and without sulphur.

PAVEMENTS

Philadelphia. Street Paving in Philadelphia. Public Works, vol. 49, no. 10, Sept. 4, 1920, pp. 208–210, 2 figs. Nearly $8,000,000 of work being executed this year on 1800 miles of streets and roads, League Island Park and Roosevelt Boulevard. Concrete delivered by auto truck service from central mixing plant.

Specifications. Paving for Cities of the Fourth Class, George M. Shepard. Bul. Affiliated Eng. Soc., Minn., vol. 5, no. 7, July 1920, pp. 17–28, 1 fig. Specifications drawn up for pavements constructed during 1919 by St. Paul, Minn., firm of consulting engineers.

PEAT

Gasification of. Power and Heat Economy in Railroad Operation (Kraft- und Wärmewirtschaft i Eisenbahnwesen), H. Landsberg. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 28, July 10, 1920, pp. 517–522, 1 fig. Details of the gasification of humid bituminous fuels, especially of lignite and peat and its importance in connection with electric traction. Considerations of heat economy suggest a combined oil-engine and electric power plant for the consummation of which problems, such as recovery of by-products, gas turbines, etc., must be solved.

PETROLEUM

Great Britain. British and Colonial Petroleum Resources, Henry B. Milner. Can. Min. Jl., vol. 41, no. 35, Sept. 3, 1920, pp. 716–721, 1 fig. Review of oil situation.

Ontario. Future Prospects for Oil and Gas Production in Ontario, M. U. Williams. Can. Chem. Jl., vol. 4, no. 7, Sept. 1920, pp. 246–248. Extent to which various geological formations have been searched for oil and results obtained. Paper read before Can. Min. Inst.

[See also OILS, Mineral.]

PHOTOGRAPHY

Color. The Prospects for Color Photography (Die Aussichten der Farbenphotographie), Felix Formstecher. Deutsche Optische Wochenschrift, no. 15–16 and 19–20, Apr. 15 and May 11, 1920, pp. 131–132 and 162–165. Deals with color photographs in which the color values are positively established by the process of production, from the so-called photographs in natural colors.

PIERS

New York City. $50,000,000 Pier Improvement Will Give New York 18 Modern Piers. Mar. News, vol. 7, no. 4, Sept. 1920, pp. 112–114, 2 figs. Plans approved by Sinking Fund Commission. Plans provide for building of 18 piers from 950 to 1025 ft. in length along North River between Vesey and Perry streets, replacing 32 erected in 1871. Work is expected to be started in spring of 1921.

PILE DRIVERS

Steam Hammers. A New Method of Driving Piles. Public Works, vol. 49, no. 6, Aug. 7, 1920, pp. 136–138, 3 figs. Account of driving reinforced-concrete piles 44 ft. long and 16 in. square by double-acting no. O "Union" steam hammer making 110 strokes per minute and operated by three-drum, three-spool 60-hp. Lidgerwood steam hoisting engine on platform of special steel tower.

PIPE LAYING

Lowering in Sea. Sea Water for Oil Refinery Condensers Secured by Gravity, Leon H. Watts. Eng. News-Rec., vol. 85, no. 7, Aug. 12, 1920, pp. 324–325, 4 figs. Thirty-inch cast-iron pipe extending 850 ft. to sea lowered from trestle as one length. Water jets used to dig trenches.

PIPE LINES

Underground, Detection of. Method of Detecting Underground or Covered Metal Pipes and Conductors (Verfahren zur Auffindung unterirdisch oder verdeckt verlegter, metallischer Leitungen), Max Dieckmann. Elektrotechnische Zeitschrift, vol. 41, no. 22, June 3, 1920, pp. 435–436, 4 figs. With aid of rapid electric oscillations. The high-frequency energy is transmitted from an exciter system to the desired conductor through induction, and the high-frequency field generated around pipe or conductor is located with an indicator sensitive to oscillations.

Welding. Welding Pipe Lines. Gas Industry, vol. 20, no. 8, Aug. 1920, pp. 189–190. Comparison of oxy-acetylene welding of pipe lines with screw-threaded connections for oil-carrying purpose. It is said that oxy-acetylene welding has proved successful and costs less, saving of welding increasing as size of pipe is increased.

POLE LINES

Telegraph and Signal-Service. Pole Lines for Telegraph and Signal Service, Stanley Rhoads. Ry. Signal Engr., vol. 13, no. 9, Sept. 1920, pp. 364–369, 2 figs. Method of calculating class and number of wood poles required for proper factor of safety in railroad service.

POLES, WOODEN

Impregnating Methods. Poles for Overhead Line and Means for Increasing Their Life (Ueber Freileitungsmasten und Mittel zur Erhöhung ihrer Lebensdauer), J. Schmidt. Elektrotechnischer Anzieger, vol. 37, nos. 67, 68–69, 73, 74, 78 and 79, Apr. 27, 29, May 6, 8, 15 and 18, 1920, pp. 289–290, 295–296, 319–320, 323–324, 339–340 and 345–346, 18 figs. Describes various impregnating methods and substances for treating wooden poles, as well as methods of reinforcing poles decayed at ground line, setting poles in concrete, etc.

POSTAL SERVICE

Mechanical Installations in England. Mechanical Installations in English Postal Service (Installations mécaniques dans le service postal anglais), M. Cabanne. Annales des Postes, Télégraphes et Téléphones, vol. 9, no. 2, June 1920, pp. 235–258, 14 figs. Description of London postal underground railway, organization of routine work in post offices and automatic pick-up apparatus.

POTASH

Recovery at Cement Plant. Successful Potash Recovery at Cement Plant. Rock Products, vol. 23, no. 18, Aug. 28, 1920, pp. 17–20, 14 figs. Improvements to Cottrel elelectrical precipitation process at plant of Santa Cruz Portland Cement Co. Fine, dry potash salt is obtained direct from stock gases.

POWER

Manufacture of. Energy as a Basic Commodity, Walter N. Polakov. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 232–239, 2 figs. Application of pronciples of multiple production and common carrier distribution.

POWER FACTOR

Minima Values. Regulations for the Minima Values of cos φ under Full Load of Motors (Règlement pour les valeurs minima des cos φ à pleine charge des moteurs). Revue générale de l'Électricité, vol. 8, no. 2, July 10, 1920, pp. 50–51. Regulations adopted by Union des Syndicats de l'Électricité on April 14, 1920.

POWER GENERATION

New England. Survey of New England Power Situation, Carroll H. Shaw. Elec. World, vol. 76, no. 11, Sept. 11, 1920, pp. 525–527. Analysis of reports received by power section of war industries board indicates total production of more than 5,000,000 kw-hr. by central stations during 1923. Estimated increase of 1,400,000 kw., 1919–1924, inclusive.

PRESSES

Crankshaft-Straightening. Metalwood Crankshaft-Straightening Presses, J. V. Hunter. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, pp. 256–258, 6 figs. Line of hydraulic power presses for straightening automotive crankshafts, developed by Metalwood Manufacturing Co., Detroit, Mich.

Forging, Automobile Parts. Construction and Operation of Forging Presses for the Manufacture of Automobile Parts (Bau und Betriebsweise von Schmiededepressen zur Herstellung von Automobil-Konstruktionsteilen), Fritz Duesing. Allgemeine Automobil-Zeitung, vol. 21, no. 18, May 1, 1920, pp. 28–30, 14 figs. Describes two methods of manufacturing crankshafts, namely, from flat forged pieces by sawing out, and by forming in dies.

PRESS WORK

Examples of. A Difficult Piece of Press Work, Frank A. Stanley. Am. Mach., vol. 53, no. 4, July 22, 1920, pp. 164–165, 5 figs. Tools required in production of sheet-steel piece of rectangular cross-section tapering from end to end and having numerous ears and flanges at various points along its contour.

PROFIT SHARING

International Harvester Co's. Plan. Details of Harvester Stock Distribution. Iron Age, vol. 106, no. 10, Sept. 2, 1920, pp. 576–577. Extra compensation and stock ownership plan adopted by stockholders of International Harvester Co. on July 29, to become effective as of Jan. 1, 1920. Arrangement supersedes profit-sharing plan adopted Dec. 23, 1915.

PULVERIZED COAL

Burners. Pulverized Coal (Charbon pulvérisé), Hugh Savage. Revue Universelle des Mines, vol. 6, no. 1, July 1, 1920, pp. 5–48, 17 figs. Modern furnaces and burners for burning pulverized coal, including types used in locomotives.

Plants. Modern Coal-Pulverizing Plant at the United Verde, J. B. Johnson. Eng. and Min. Jl., vol. 110, no. 8, Aug. 21, 1920, pp. 358–360, 6 figs. Jeffrey breakers followed by Ruggles Coles driers and Raymond pulverizers. Powdered coal carried to smelter bins by screw conveyors and blown to drier burners with 40-lb. air. 750-ton plant erected at cost of $725,000.

The New Lakeside Pulverized-Coal Plant, Milwaukee. Power, vol. 52, no. 10, Sept. 7, 1920, pp. 358–360, 1 fig. Ultimate capacity to be 200,000 kw. Initial installation of 40,000 kw. Features are long, low, bungalow type of building, special coal handling and preparation equipment, burners of horizontal and vertical types and 500-kw. turbogenerator to supply current for station auxiliaries which will exhaust to feedwater heaters and by thermostatic regulation maintain temperature of feedwater.

PUMPING STATIONS

Electrically Operated. Five Thousand Horse Power Electrically Operated Pumping Plant, E. Bachman and W. J. Delehanty. Gen. Elec. Rev., vol. 23, no. 8, Aug. 1920, pp. 684–687, 5 figs. Plant has total capacity of 676,000,000 gal. of water per day.

PUMPS

Corrosive-Liquid. Pumps for Corrosive Liquids. Eng., vol. 110, no. 2851, Aug. 20, 1920, pp. 253–254, 6 figs. Made of modified form of ceratherm, said to have higher tensile strength and to possess further advantage of being more easily manufactured to accurate dimensions.

Rotary. A New Type of Pump (Un nuovo tipo di pompa). Industria Meccanica, vol. 2, no. 7, July 1920, pp. 217–218, 5 figs. Novel type of rotary pump manufactured by the Officine Meccaniche Gallaratesi-Gallarate.

Submersible. Submersible Electric Motor Pump, T. L. Reed Cooper. Eng., vol. 110, no. 2852, Aug. 27, 1920, pp. 274–275, 5 figs. Suction connection is formed in other end cover and water passes in longitudinal direction through helical passages in rotor to impeller. Stator windings and lamina-

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ENGINEERING INDEX (Continued)

tions are contained in closed annular chamber practically filled with transformer oil. Pump comprises three-phase induction motor having squirrel-cage rotor to one end of which pump impeller is attached while volute chamber and delivery connection are formed in other end cover.

PUMPS, CENTRIFUGAL

Electrically Driven. The Economy Resulting from the Use of Variable Speed Induction Motors for Driving Centrifugal Pumps, Melvin L. Enger and William J. Putnam. Mun. and County Engineering, vol. 59, no. 2, Aug. 1920, pp. 69–72, 3 figs. Tests showing relative overall efficiencies of motor-driven three-stage centrifugal pump for various heads and discharges when speed is varied and pump run at normal speed with discharge throttled.

Tests. High-Pressure Centrifugal Pumps (Les pompes centrifuges à hautes pression), Ch. Hanocg. Revue universelle des Mines, vol. 6, no. 3, Aug. 1, 1920, pp. 169–201, 37 figs. partly on 3 supp. plates. Tests made at Laboratory of Applied Mechanics and Industrial Physics, Liège University. (To be continued.)

PUNCHING

High-Speed, Laws of. The Laws of High-Speed Punching. Engr., vol. 130, no. 3373, Aug. 20, 1920, pp. 126–127. Among laws formulated from technical considerations and results of experimental work is that when any given body, in virtue of kinetic energy, passes completely through another given body without undergoing any change whatever of its own form or dimensions, power it exerts in effecting necessary rupture of material of perforated body is constant for all velocities. From paper issued by British War Office.

PYROMETERS

Radiation. Modern Radiation Pyrometers (Les pyromètres modernes à radiation), L. Neuray Revue Universelle des Mines, vol. 6, no. 2, July 15, 1920, pp. 127–143, 12 figs. Féry and Thwing types.

R

RADIOTELEGRAPHY

Amplifiers. An Alternating-Current Zero Method for the Determination of the Grid Sensibility of Amplifier Tubes (Eine Wechselstrom-Nullmethode zur Bestimmung der Gitterempfindlichkeit von Verstärkerröhren), W. Schottky. Telegraphen- u. Fernsprech-Technik, vol. 9, no. 2, May 1920, pp. 31–32, 1 fig. Describes a connection which is being satisfactorily used in tube-testing room of the Werner Works K Laboratory.

Antennae. The Braun Frame Antenna (Die Braunsche Rahmenantenne), C. W. Kollatz. Elektrotechnischer Anzeiger, vol. 37, no. 87, June 1, 1920, pp. 386–395, 2 figs. Describes frame antenna consisting of a flat, usually square, wooden frame on which a wire is wound in six to ten windings thus developing a coil of large diameter and forming, in connection with an adjustable condenser, a closed oscillating circuit which is coupled with the oscillating circuit of the receiver by means of a coupling coil. Points out advantages of frame antennae over open antenna.

Audions. Graphical Theory of the Audion Generator and Calculation of Amplitude of Oscillations (Théorie graphique des audions générateurs et calcul de l'amplitude des oscillations), A. Blondel. Radioéléctricité, vol. 1, no. 1, June 1920, pp. 7–13, 2 figs. Starting with idea that audion generator requires great amplitude in variation of plate current, writer transforms graph of static characteristics of voltage and amperage of plate into dynamic by a graphical method. (To be continued.)

Utilization of Amplifying Valves for Electrical Measurements (Utilisation des lampes amplificatrices pour les mesures électriques), Henri Abraham. Annales des Postes, Télégraphes et Téléphones, vol. 9, no. 2, June 1920, pp. 197–207, 8 figs. Carpentier direct-reading amplifying voltmeter.

Direction Senders. New Experiments with Radiotelegraphic Direction Senders (Neue Versuche über funkentelegraphische Richtsender), Franz Kiebitz. Jahrbuch für drahtlose Telegraphie u. Telephonie, vol. 15, no. 4, Apr. 1920, pp. 299–310, 6 figs. By means of suitable regulation of the current strength of antennae it was possible to transmit a message to a distant station where it was clearly understood without being deciphered by six stations in closer vicinity to sender station. Problem is thus solved of telegraphing not only on straight lines, but also on circles.

High Altitudes. Wireless Telegraphy at High Altitudes (Funkentelegraphie in grösseren Höhen), Felix Jenzsch-Graefe. Jahrbuch für drahtlose Telegraphie u. Telephonie, vol. 15, no. 4, Apr. 1920, pp. 311–317, 3 figs. Relates experiences at the front where it was observed that frequently at a height of about 6000 m. communication with the earth and reception in aeroplane was no longer possible. Causes for this failure were investigated and remedies suggested.

Hourly Signals. The Reception of Hourly Signal. (La réception des signaux horaires), Michel Adams Radioélectricité, vol. 1, no. 2, July 1920, pp. 97 101, 8 figs. Scheme of signals sent out from Eiffel tower, Paris.

Maintained Oscillations. New Method of Calculating in Radiotelegraphy by Separating Real Power and Reactive Power (Nouvelle méthode de calcul par la séparation des puissances, appliquée à la radiotélégraphie), P. Poucherot. Radioélectricité, vol. 1, no. 2, July 1920, pp. 73–77. Calculations of alternating currents by considering real power and reactive power separately. Method is illustrated in example of antenna to send maintained oscillations of 6000 meters in length.

Radiogoniometric Stations. European Radiogoniometric Stations (Les stations radiogoniometric européennes), Radioéléctricité, vol. 1, no. 1, June 1920, pp. 38–39, 1 fig. List of French, English and German stations.

Stations. Subterranean Wireless Telegraphy Station Organized at Paris during the War (Organisation d'un grand poste de télégraphie sans fil souterrain pendant la guerre). Radioélectricité, vol. 1, no. 1, June 1920, pp. 14–18, 9 figs. Antennæ consisted of two steel cables stretching from Eiffel tower to the two towers of the Trocadero Palace. Machinery was located in tunnel which was under construction for additional line of Paris subway.

The LaFayette Radiotelegraphic Station (La station radiotélégraphique La Fayette). Radioélectricité, vol. 1, no. 2, July 1920, pp. 78–81, 3 figs. Antenna is supported by eight metal towers, 825 ft. high, successively spaced apart a distance of 1320 ft. and forming a rectangle 1960 ft. by 1320 ft. Wave length used is $12^1/_2$ to $15^1/_2$ miles.

The New Radio Station at Lyons, Leon Faljan. Wireless Age, vol. 7, no. 12, Sept. 1920, pp. 11–14, 7 figs. Features are Elwell design of Poulsen arc and double system of speed control of 20,000-cycle generator set.

[See also ELECTRON TUBES; OSCILLATIONS; VACUUM TUBES.]

RADIOTELEPHONY

Receivers, Galena-Metal. Galena-Metal Telephone Receiver (Sur le récepteur téléphonique autodétecteur pointe-crystal ou pointe-métal), R. Dongier. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 4, July 26, 1920, pp. 238–240. Experimental research is said to have demonstrated that receiver composed of contact between metallic point and galena reproduces human voice faithfully and with remarkable clarity.

Secret. Systematic Deformations of Telephonic Currents. Application to a Process of Secret Telephony (Sur les déformations systematiques des courants téléphoniques. Application à un procédé de téléphone secrète), E. Poirson. Bulletin de la Société française des Électriciens, vol. 10, no. 88, April 1920, pp. 147–161, 7 figs. Current is deformed at sending station by apparatus which inverts it periodically. It is rectified at receiving station by similar apparatus operating in synchronism with apparatus at sending station. Deformation renders current unintelligible in line.

RAILWAY ELECTRIFICATION

Economics. Railway Electrification (Application de la traction électrique aux grandes lignes de chemin de fer), Philip Dawson. Association des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, Bulletin, vol. 2, nos. 1–2–3–4, Jan.-Feb.-March-April 1920, pp. 5–23. Economics of railway electrification, with reference to problem in Belgium.

England. The Ealing and Shepherd's Bush Railway, Ry. Engr., vol. 41, no. 488, Sept. 1920, pp. 380–382, 5 figs. New electrified section of Great Western Railway furnishes an additional through route between Ealing and Liverpool Street via Wood Lane and Central London Railway.

France. Electrification of the French Railways (L'électrification des chemins de fer français). Vie Technique et Industrielle, vol. 1, no. 10, July 1920, pp. 307–310, 8 figs. Project for electrification of 1838 miles of the Southern Ry. of France and 1900 miles of Paris-Orleans Ry.

Prussian Railways. Electrification of the Prussian Railways in Silesia. Elec. Ry. Jl., vol. 56, no. 11, Sept. 11, 1920, pp. 499–502, 8 figs. Single-phase power with 15,000 volts on contact line is used. Interconnected water-power plants with steam auxiliary furnish power. Several types of locomotive are required to cover all classes of requirements. From article by E. C. Zehme in Elektrotechnische Zeitschrift.

RAILWAY MAINTENANCE

Car Inspection. Basing Car Inspection on Energy Consumption, L. E. Gould. Elec. Traction, vol. 16, no. 8, Aug. 1920, pp. 557–559, 1 fig. Method is said to insure that each car will be uniformly announced for inspection when it has done requisite amount of work to require it.

RAILWAY OPERATION

Telegraph vs. Telephone. The Telegraph and Telephone for Train Orders. Ry. Signal Engr., vol. 13, no. 9, Sept. 1920, pp. 375–379. Interstate Commerce Commission statistics show that telephone is replacing telegraph.

RAILWAY SHOPS

Hydraulic Presswork. Norfolk & Western Railroad Shop Kinks. Ry. & Locomotive Eng., vol. 33, no. 9, Sept. 1920, pp. 256–257, 5 figs. Method of rolling copper bushing in hydraulic press.

RAILWAY SIGNALING

Interlocking Machines. A Unique Crossing Gate Arrangement, Paul F. Bunker. Ry. Signal Engr., vol. 13, no. 9, Sept. 1920, p. 363, 1 fig. Apparatus and circuits for gate control from electro-pneumatic interlocking machine.

Electro-Mechanical Interlocking at Sunbury, Pa., John Moore. Ry. Signal Engr., vol. 13, no. 9, Sept. 1920, pp. 371–373, 3 figs. A. c. power is used for electric functions except signal control relays and locks on machine.

Overlap vs. A. P. B. Overlap vs. A. P. B. Signaling Single Track. Ry. Age, vol. 69, no. 11, Sept. 10, 1920, pp. 439–441. Comparative merits from operating standpoint. Opinions expressed by signal engineers at meeting of St. Louis Sectional Committee of Signal Division, Am. R. R. Assn.

Systems. What Scheme of Signaling Is Most Desirable? Ry. Signal Engr., vol. 13, no. 9, Sept. 1920, pp. 356–359, 3 figs. Comparative value of schemes. Abstracts of papers presented at meeting of St. Louis Sectional Committee of Am. Railroad Assn. Titles discussed were: Absolute Permissive Block Signaling, A. R. Fugina, Straight Automatic Blocking on the U. P. System, A. H. McKeen, and S. P. Single Track Signaling, E. E. Worthing.

RAILWAY TRACK

Improvement. Improvements in Railway Track Construction (Neuerungen im Eisenbahnoberbau), Jos. Weig. Zentralblatt der Bauverwaltung, vol. 40, no. 27, Apr. 3, 1920, pp. 158–160, 6 figs. Describes new method of diminishing possibility of shifting of interior portions of the ballast through reinforcement with especially shaped reinforced concrete grids under both ties at a rail joint, thereby increasing the load capacity of ballast.

Tie Plates. Principles to Be Followed in Tie Plate Design, Howard H. George. Elec. Ry. Jl., vol. 56, no. 8, Aug. 21, 1920, pp. 359–361, 2 figs. Specifications for steel tie plates. Results of tests carried out by New York Central Railroad.

Transition Curves. New Transition Curve Based upon the Lemniscate, J. E. Williams. Eng. News-Rec., vol. 85, no. 9, Aug. 26, 1920, pp. 406–407, 3 figs. Method of locating points of curve.

The True Transition Curve for Railway Problems, George Paaswell. Eng. News-Rec., vol. 85, no. 9, Aug. 26, 1920, pp. 407–409, 4 figs. Suggested simplification on mathematical work. Functions of true transition curve, with tables for supplying curve in practice.

RAILWAYS

Baghdad. The Baghdad Railway. Eng., vol. 110, no. 2849, Aug. 6, 1920, pp. 174–175 and p. 184, 8 figs. Notes on construction and equipment.

Snow-Fighting Equipment. Snow Fighting Equipment, W. H. Winterrowd. Can. Ry. & Marine World, no. 271, Sept. 1920, pp. 469–475, 16 figs. Survey of types developed, with special reference to those recently operated by Canadian Pacific Railway.

RAILWAYS, MILITARY

Operation. Field Railway Operation (Das Feldeisenbahnwesen), H. Bode. Annalen für Gewerbe u. Bauwesen, vol. 86, no. 11, June 1, 1920, pp. 88–94. Account of organization of the field railway in its development during the war, in connection with which certain special problems are discussed, such as schedule planning, speeds, repair of parts, and the procuring of construction material. Address read before Assn. German Machine Engrs.

RECTIFIERS

Mercury-Vapor. The Mercury Vapor-Arc Rectifier in Its Present Development (Der Quecksilberdampf-Gleichrichter in seiner jetzigen Entwicklung), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 37, nos. 98 and 99, June 19 and 23, 1920, pp. 443–444 and 449, 6 figs. Describes theoretical basic principles of these rectifiers and gives constructive details of latest standard models of Brown, Boveri & Co. and Gen. Elec. Co.

REDUCTION GEARS

Design. Reduction Gears for Marine Turbines (Réducteurs de vitesse a engrenages pour turbines marines), M. Vasset. Bulletin technique du Bureau Veritas, vol. 2, nos. 7 and 8, July and Aug., 1920, pp. 134–138 and 161–164, 11 figs. Technical notes on helicoidal gears. Materials employed in construction of gears.

REFLECTORS

Parabolic. The Electrolytic Manufacture of Parabolic Reflectors, Samuel Wein. Brass World, vol. 16, no. 8, Aug. 1920, pp. 218–220. Summary of patents and recent improvements in manufacturing process.

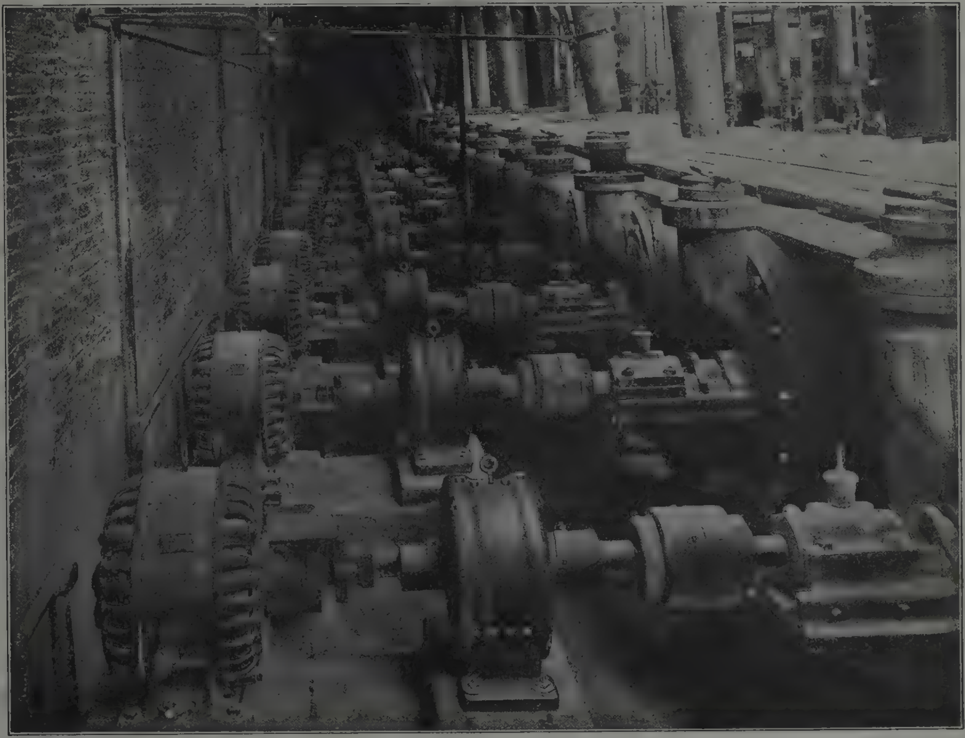
REFRACTORIES

Physical Properties. Physical Characteristics of Specialized Refractories, M. L. Hartmann, A. P. Sullivan and D. E. Allen. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 1, pp. 1–15, 10 figs. Tests of electrical resistivities of nine commercially used refractory materials at temperatures up to 1500 deg. cent. Measurements were taken while heating up slowly and while cooling down slowly, thermocouple measuring temperature being outside specimens.

Zirconia, Silica. An Approximate Determination of the Melting-Point Diagram of the System Zirconia–Silica, Edward W. Washburn and Earl E. Libman. Jl. Am. Ceramic Soc., vol. 3, no. 8, Aug. 1920, pp. 634–640, 2 figs. It was determined in tests that for use as refractory up to about 2550 deg. cent. presence of silica as "impurity" in zirconia is not detrimental since fluxing action can be eliminated by adding enough more silica to bring total content up to 33 per cent. It is believed that refractories of considerable strength may be manufactured from powdered zircon bonded with small quantity of mixture of zirconium hydroxide and precipitated silica in molecular proportions and fired in electric furnace.

[See also RESEARCH, Refractories.]

EFFICIENCY



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ENGINEERING INDEX (Continued)

RESEARCH

Coal. Research upon the Chemistry of Coal and Combustion, William A. Bone. Combustion, vol. 3, no. 3, Sept. 1920, pp. 24–25. Urges establishment of national policy with regard to research upon chemistry of coal and combustion and points out how such policy could be carried out in best interests both of progress in science and economic development of coal fields.

Researches on Coal and Gases Obtained by Its Distillation (Recherches sur la houille et les gaz provenant de sa distillation), Leo Vignon. Annales de Chimie, vol. 13, no. 9, May-June, 1920, pp. 284–301. Studies comprise (1) coal solvent, (2) composition of gases obtained by distillation of coal at different temperatures, (3) influence of composition of coal on proportions of carbon oxide and carbonic acid present in coal gas, and (4) elimination of carbon oxide from coal gas.

Concrete. Recent Advances in Concrete Practice. Ry. Maintenance Engr., vol. 16, no. 9, Sept. 1920, pp. 334–336. Summary of work undertaken at Structural Matls. Research Laboratory established in 1914 at Lewis Inst., Chicago.

Explosives. The Research Department, Woolwich, Robert Robertson. Nature (Lond.), vol. 105, no. 2649, Aug. 5, 1920, pp. 710–712, 3 figs. Work done with regard to explosives, particularly TNT (To be continued.)

Glass Industry. Putting the Glass Industry on a Scientific Basis, E. Ward Tillotson. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 461–465, 4 figs. Role of modern science in ancient art of glassmaking. Developments due to engineering. Refractories and raw materials. Accomplishments of chemist.

Government-Conducted. The Economic Importance of the Scientific Work of the Government—III, Edward B. Rosa. Sci. Monthly, vol. 11, no. 3, Sept. 1920, pp. 246–253. It is argued that "government should be constructive and helpful to the people and to business wherever possible," that "government would spend less for its purchases if it spent more in standardizing products purchased and in testing deliveries systematically," and principally "that research and development work by the government develop wealth and the burdening of taxation is thereby lightened."

Great Britain. The Excess Profits Duty and Scientific Research. Jl. Soc. Chem. Industry, vol. 39, no. 15, Aug. 16, 1920, p. 265R. Comments on clause of British Finance Bill by which contributions made for charitable, educational and scientific (research) objects are to be allowed as deductions in computing excess profits duty.

Industrial. The Need of Research in the Industrial Field, P. F. Walker. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 487–491. Discussion of problems which await engineer in field of industry. Emphasis is laid upon study of economics upon location of industry, pointing out unfortunate conditions which now exist in Kansas and neighboring states solely because this problem is as yet unsolved. It is said that problem is distinctly an engineering one. An abstract of report prepared by Research Committee of Mid-Continent Section of Am. Soc. Mech. Engrs. is included.

Industrial Laboratories. A Novel Laboratory for Industrial Research. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 496–498, 3 figs. Description of research laboratory organized to study and develop new and economical problems relating to chemical and metallurgical processes and equipment, with enumeration of some problems which are being studied.

Experimental and Research Laboratory of the Hall-Scott Motor Car Company, Richard Vosbrink. Metal Trades, vol. 11, no. 9, Sept. 1920, pp. 370–372. Equipment for testing automobile engines.

Leather Industry. The Leather Industry, John Arthur Wilson. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 457–460, 4 figs. Points out that many problems awaiting solution in such phases of leather manufacture as unhairing, deliming, bating, tanning, stuffing and dyeing involve fundamental scientific principles which can best be studied through coöperation between university and tannery chemists.

Metallurgical. The Research Department, Woolwich—II, Robert Robertson. Nature (Lond.), vol. 105, no. 2650, Aug. 12, 1920, pp. 743–745, 3 figs. Metallurgical studies.

Oil-Shale Industry. The Necessity for Research in the Oil-Shale Industry, Martin J. Gavin. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 489–495, 4 figs. Account of shale-oil industry as developed in Scotland. Steam-regulated pyrolytic distillation. Quality and quantity of oil yields.

Pulp and Paper Industry. The Future of Chemical and Engineering Research in the Pulp and Paper Industry, John Stevens, 3d. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 451–453, 3 figs. Prospectus on pulp and paper research. By-product possibilities and reduction of wastes. Less liquor dilution by more efficient washing. Fuel and power costs reduced by use of vacuum drying and better designed beaters.

Refractories. Extend Facilities for Refractories Testing. Brick & Clay Rec., vol. 56, no. 12, June 1, 1920, pp. 1100–1101. It is announced that facilities of fellowship endowed by Refractories Manufacturers' Assn. at Mellon Inst. of Indus. Research of University of Pittsburgh are now open to individual firms and corporations not manufacturers of refractories, according to resolution adopted on April 20 by Assn.

Rolling Mills. The Bureau of Rolling-Mill Research, W. B. Skinkle. Proc. Engrs. Soc. Western Pa., vol. 36, no 5, June 1920, pp. 295–328 and (discussion) pp. 329–344, 42 figs. Plans for research mill which is to be built at Carnegie Inst. of Technology by organization of steel and equipment manufacturers and engineers.

Rubber. Future Rubber Research, Andrew H. King. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 449–450. Appeal for more and improved methods of testing rubber and its products as guide to compounding. Need for study of fabric and design of products. Continuous vulcanizing and temperature control essential.

[See also COLLOIDS, Research.]

RESERVOIRS

Water Level, Measurement of. The Pneumercator. Elec. Times, vol. 58, no. 1504, Aug. 12, 1920, pp. 128–129, 3 figs. Apparatus for measuring height of water in reservoirs. Also applicable to any other liquid. Device is used in U. S. Navy for oil-tank readings.

RETAINING WALLS

Gravity Type. Some Features of Gravity Retaining Walls, S. W. B. Black. Can. Engr., vol. 39, no. 8, Aug. 19, 1920, pp. 259–262, 2 figs. Types of failure to be guarded against. Top width, batter and stepping of back; extending the toe; drainage; expansion joints; careful depositing of back filling.

RIVERS

Reef Removal. Removal of Reefs in the Rio Guadiana, J. S. Owens. Engr., vol. 130, no. 3374, Aug. 27, 1920, pp. 201–202, 2 figs. Methods of drilling and blasting employed. Paper read before Eng. Section, British Assn. for Advancement of Science.

Rhone. The Harnessing of the Rhône (L'amenagement du Rhône), E. Pellissier. Revue de l'Ingenieur et Index technique, vol. 27, no. 1, July 1920, pp. 3–23, 10 figs. Existing installations are studied and possible further developments are visualized. (To be continued.)

Yearly Run-Off Variations. The Probable Variations in Yearly Run-Off as Determined from a Study of California Streams, L. Standish Hall. Proc. Am. Soc. of Civil Engrs., vol. 46, no. 6, Aug. 1920, p. 950. Data of California streams are studied with a view to constructing probability graph on which, by means of straight-line relation, probable minimum and maximum yearly run-offs which are likely to occur once in a period of 100 years may be determined for any stream from available run-off data for that stream. (Abstract.)

RIVETED JOINTS

Stress Determination in. Determination of Surface-Distortion and Stress Conditions and Its Application to a Plate Stressed by Two Rivet Bolts (Ermittlung ebener Verschiebungs- und Spannungszustände und Anwendung auf eine durch zwei Nietbolzen gespannte Platte), Dietrich Rühl. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 29, July 17, 1920, pp. 549–554, 11 figs. Based on general theories of the distribution of force in riveted tension-resisting joints, a problem of special importance in structural work is solved by author. Description of apparatus used for purpose which, it is claimed, can be used for investigation of every biaxial stress condition.

ROAD CONSTRUCTION

Adjusting Earth Excavation. New method for Adjusting Earth Excavation and Determining Haul, J. W. Ball and C. R. Shore. Can. Enr., vol. 39, no. 10, Sept. 2, 1920, pp. 297–299, 6 figs. Graphical methods based on "quantities" diagram and "excess area" diagram.

ROADS

See DRAINAGE, Open Ditches vs. Tile Drains.

ROADS, CONCRETE

Road Plant. The Layout and Operation of a Road Plant at Charles City, Thure W. Ingemanson. Concrete, vol. 17, no. 2, Aug. 1920, pp. 49–52, 15 figs. Organization of material handling and mixing crews for construction of concrete road in Federal Aid project No. 41, in Floyd County, Iowa.

Specifications. Suggested Composite Specifications for Concrete Roadway Construction, S. M. Feinberg. Mun. and County Eng., vol. 59, no. 2, Aug. 1920, pp. 52–55. Specifications are presented as compilation from various up-to-date sources, such as American Concrete Institute, the New York state and other state and federal authorities, supplemented by personal experience of writer.

Surface Cracks. Concealed Joints in Road Slab Limit Surface Cracks, Samuel H. Lea. Eng. News-Rec., vol. 85, no. 7, Aug. 12, 1920, p. 305. Extra durable roads said to be secured by wood floating as sifted layer of cement and sand into green concrete.

ROLLING MILLS

British. New Mill of Messrs. Monks, Hall and Company, Limited. Iron & Coal Trades Rev., vol. 101, no. 2738, Aug. 20, 1920, pp. 230–231, 8 figs. Mill is 14-in. 3-high tandem, bolting rolls being 18 in. in diameter. Driven by Siemens 400-hp. d.-c. compound-wound mill-type motor, arranged to give speed variation between 92 and 125 r.p.m.

Control Equipment. Control of Mill Tables and Screw Downs, Walter C. Kennedy. Assn. Iron & Steel Elec. Engrs., vol. 2, no. 8, Aug. 1920, pp. 19–33 and (discussion), pp. 33–49, 9 figs. Design of control equipment.

Electric Drive. Electric Drive for Rolling Mills (La commande électrique des trains de laminoirs), F. Robin Technique Moderne, vol. 12, no. 5, May 1920, pp. 199–203, 4 figs. Calculation of power required. (To be continued.)

Plate Mills. First Plate Mill Built in Canada. Can. Manufacturer, vol. 40, no. 9, Sept. 1920, pp. 53–55, 2 figs. Plate mill built at Sidney, Nova Scotia by Dominion Iron & Steel Co. Buildings cover area of 240,000 sq. ft. and are of modern mill-type construction, structural steel frames with brick walls. Drive is furnished by General Elec. Co. 88-pole, 4000-hp., 82 r.p.m., induction, 3-phase, 60-cycle motor.

Rolling Multiple Ingots. Rolls Horseshoe Blanks Direct from Small Ingots Cast in Multiples of 30, J. G. Webb. Iron Trade Rev., vol. 67, no. 4, July 22, 1920, pp. 232–233, 6 figs. Interchangeable mold sections when clamped together form cluster of ingot molds. To shake out hot ingots sections are supported by pipe through rings, clamp is removed and ingots drop from freed molds. Ingots are rolled, sheared and finished.

Theory of. The Present Status of the Theory of the Rolling-Mill, W. Trinks. Proc. Engrs. Soc. Western Pa., vol. 36, no. 5, June 1920, pp. 275–294, 20 figs. Elements available for developing complete theory dealing with (1) forces between stock and rolls, (2) deformation of stock, and (3) effect of forces upon mill.

[See also RESEARCH, Bureau of Rolling Mill Research.]

ROPEWAYS

See CABLEWAYS.

RUBBER

Vulcanized, Preservation of. The Preservation of Vulcanized Rubber, Henry P. Stevens. Jl. Soc. Chem. Industry, vol. 39, no. 14, July 31, 1920, pp. 251T–253T. Experimental. It is said that life of vulcanized rubber is prolonged by storing in air saturated with moisture or petroleum vapor. It is claimed that even overcured rubber can be preserved by this means for 6 or 7 months at tropical temperatures.

S

SAFETY

Great Britain. Progress of the Safety Movement in Great Britain, Frederick L. Hoffman. Safety Eng., vol. 40, no. 2, Aug. 1920, pp. 54–62. Report to Executive Committee of National Safety Council.

SAND

Sand-Gravel Plants. New Type of Sand-Gravel Plant. Rock Products, vol. 23, no. 18, Aug. 28, 1920, pp. 34–37, 10 figs. Pumping is done directly into head screen instead of a dewatering sump as is customary. Other features in pumping and screening plant.

SAWS

Circular, Power Required. Investigations of Power Consumed in Cutting Wood by Means of Circular Saws with Set Teeth (Untersuchungen über den Nutzarbeitsverbrauch bei der Spanabhebung am Holze durch geschränkte Kreissägen), Karl Wasserberger. Der praktische Maschinen-Konstrukteur, vol. 53, no. 18, May 6, 1920, pp. 65–87, 13 figs. A general equation is worked out and tested, and coefficients for different specimens of soft wood and hard wood are determined from the results of cutting tests according to the method of the smallest square. Influence of the bluntness of teeth on amount of mechanical energy consumed is determined in the case of hard and soft wood. Bibliography.

Hack. The Manufacture of Hack Saw Blades. Machy. (Lond.), vol. 16, no. 414, Sept. 2, 1920, pp. 672–674, 5 figs. Methods used by Sheffield & Hallamshire Hack Saw Co., Ltd.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Automatic, Speed Control of. Electric Speed Control for Cleveland Automatics. Machy. (N. Y.), vol 27, no. 1, Sept. 1920, pp. 81–84, 10 figs. Mechanism which regulates amount of resistance in series with shunt field windings of adjustable-speed driving motor.

SCREW THREADS

National Screw Thread Commission. National Screw-Thread Commission Report on Coarse and Fine Threads. Am. Mach., vol. 53, nos. 11 and 12, Sept. 9 and 16, 1920, pp. 507–512 and 543–546, 4 figs. Sept. 9. Commission was created by Act of Congress, July 18, 1918, for purpose of ascertaining and establishing standards for screw threads for use of various branches of Federal Government and for use of manufacturers. Sept. 16. Tables of manufacturing tolerances for gages, and typical specifications for screw-thread production.

SEAPLANES

Commercial, German. German Commercial Seaplanes (Deutsche Verkehrs-Seeflugzeuge), Werner v. Langsdorff. Schiffbau, vol. 21, no. 33, July 7, 1920, pp. 902–906, 12 figs. Details of types developed by the Sablatnig, the Air Traffic Co., Lübeck-Travemünde Aeroplane Works, Junkers, Zeppelin-Staaken and Aircraft Co.

SELENIUM

Cells. Selenium Cell with Built-In Compensator Cell (Selenzelle mit eingebauter Kompensatorzelle), W. S. Gripenberg. Elektrotechnische Zeitschrift, vol. 41, no. 23, June 10, 1920, pp. 453–454, 1 fig. Two currents in opposite direction are sent through a selenium plate. One of the current paths can be

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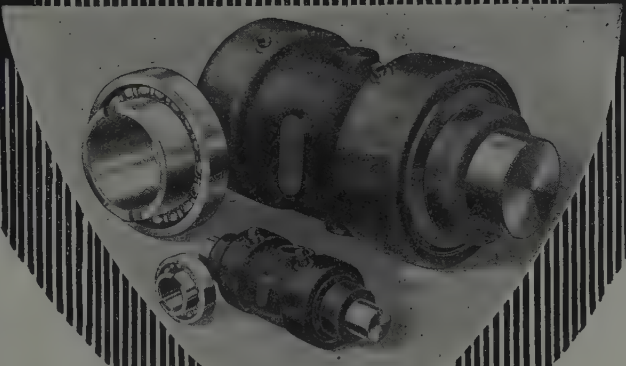

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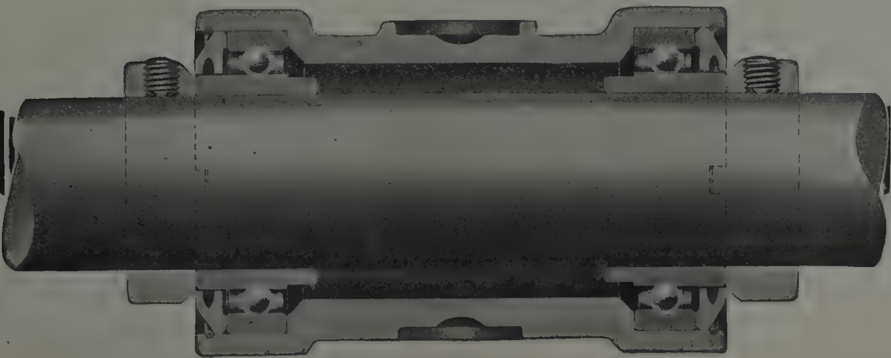

ENGINEERING INDEX (Continued)

exposed to light in order to obtain compensation of (1) spontaneous resistance variations of the selenium, (2) temperature variations, (2) partial effects of inertia, (4) sudden variations through electrochemical causes.

SEWAGE DISPOSAL

Imhoff Tanks. Some Small Imhoff Tanks, W. A. Hardenbergh. Public Works, vol. 49, no. 6, Aug. 7, 1920, pp. 122–126, 8 figs. Plans prepared by state health boards and others for sewage treatment plants for schools and institutions and small communities. Various retention periods and capacities per capita are recommended for different designs and different sizes.

Preliminary Treatment. The Preliminary Treatment of Sewage, James H. Edmondson. Contract Rec., vol. 34, no. 33, Aug. 18, 1920, pp. 794–796. Laboratory and practical experiments consisting of (1) addition of ferric sulphate to sewage at rate equivalent to 4 grains per gal.; (2) addition of 2 grains per gallon of ferric sulphate, plus 2 grains per gal. of lime; and (3) addition of 1.0 grains per gal. of aluminum sulphate and 2.8 grains per gal. of lime.

Purification. The De-Watering of Sewage Sludge, with Special Reference to the Birmingham Method, F. R. O'Shaughnessy. Surveyor, vol. 58, no. 1491, Aug. 13, 1920, pp. 111–112. In Birmingham process of rapid chemical degradation of organic contents of sludge is effected by promoting intensive fermentation in the mass, under controlled conditions. Experience during eight years of operating Birmingham installation is related. Paper presented to Engineering and Architecture Section, Royal Sanitary Institute Congress, Birmingham.

SHIP AUXILIARIES

Loading and Unloading Equipment. Loading and Unloading Equipment of Cargo Ships (Ueber die Lade- und Löscheinrichtungen der Frachtschiffe), Heinrich Meyer. Schiffbau, vol. 21, nos. 35 and 36, July 21 and 28, 1920, pp. 951–958 and 982–989, 24 figs. Gives reasons for retention of loading equipment on board ship in spite of the greater economy of harbor cranes; it is shown that loading cranes with winches are preferable to slewing cranes; comparison of 21 different loading equipment plants, from which conclusions are drawn as to most favorable methods and arrangements and maximum and minimum limits of practicability of the different arrangements. (To be continued.)

SHIP CONSTRUCTION

Bulkheads. Stiffened Bulkheads. Shipbuilding & Shipping Rec., vol. 16, no. 9, Aug. 26, 1920, pp. 266–267, 8 figs. Two new bulkhead constructions without knee plates developed in Germania Yard during past few years. Translated from Schiffbau.

Stiffened Bulkheads Without Gusset Plates—A New Bulkhead Construction Type (Versteifte Schotte ohne Kniebleche—Eine neue Schottbauart), H. Erbach and G. Schulze. Schiffbau, vol. 21, no. 32, June 30, 1920, pp. 871–873, 12 figs. Describes new construction in which smooth side and stiffened side offer equal resistance to pressure.

Loft Work. Notes on Loft Work. Shipbuilding & Shipping Rec., vol. 16, no. 9, Aug. 26, 1920, pp. 263–264, 2 figs. Hints on setting out special plating on scrieve board.

Production Systems. Production Methods in Shipbuilding—III, William B. Ferguson. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 226–232, 2 figs. Setting standards of performances.

SHIP DESIGN

Hull Resistance. Note on Resistance of Hull. Influence of Trim of Ship (Note sur les résistances de carène. Influence de l'assiette du navire), C. H. Holst. Bulletin Technique de Bureau Veritas, vol. 2, no. 8, Aug. 1920, pp. 157–161, 7 figs. Technical study. Graphs indicating normal resistances.

SHIP PROPULSION

Efficiency. The Efficiency of Propulsion of Full-Sized Ships, C. Frodsham. Eng., vol. 110, no. 2849, Aug. 6, 1920, pp. 193–196, 10 figs. It is contended that propulsive coefficient derived synthetically from model experiments is not realized in actual ship. Values of propeller efficiency, wake factor, or hull efficiency in model and actual ships are compared. Suggestions in design of ships are formulated from study of test data obtained in trials of various ships. Paper read before Instn. Naval Architects.

SHIPS

Cargo. Cargo Steamer of 4,750 Tons D. W. on 21 ft. 8 in. Draft. Shipbuilding & Shipping Rec., vol. 16, no. 11, Sept. 9, 1920, pp. 315–317, 7 figs. Dimensions: Length between perpendiculars, 324 ft.; breadth, molded, 44 ft.; depth, molded, 25 ft. 6 in.; deadweight, 4750 tons. Propelling machinery consists of single set of triple-expansion engines having cylinders $20^1/_2$ in., 33 in., and 54 in. diameter and 39 in. stroke, steam being supplied by two cylindrical boilers of usual marine type.

The P. and O. Liner "Naldera." Eng., vol. 110, no. 2852, Aug. 27, 1920, pp. 278–279, 10 figs. partly on supp. plate. Dimensions: Overall length, 605 ft.; width, molded, 67 ft.; depth, molded, 90 ft. 9 in.; gross tonnage, 15,825; draft, 29 ft. $6^3/_4$ in.; bunker capacity, 2940 tons. (To be continued.)

10,500-Ton Deadweight Cargo Carrier. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 714–716, 3 figs. partly on supp. plate. Type of vessel under construction for Shawmut Steamship Company at Chester Yard of Merchant Shipbuilding Corporation. Characteristics: Length overall, 457 ft.; beam, molded, 57 ft.; depth at side to shelter deck, 39 ft.; draft, designed load, 28 ft. 9 in.; displacement at designed load draft, 15,000 tons; speed on designed load draft, 13 knots.

Cargo Motorships vs. Steamships. Cargo Motorships vs. Steamships, Charles E. Lucke. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 759–763. Comparative calculations of expenses and earnings for operation of steam and motor ships. (To be concluded.)

Ice Breakers. Ice-Breakers, John Flodin. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 707–712, 5 figs. Characteristics of vessels designed expressly as ice breakers. American and European practice. Work in pack ice.

Passenger. T. SS. "Versailles." Shipbuilding & Shipping Rec., vol. 16, no. 10, Sept. 2, 1920, pp. 285–286, 4 figs. Geared-turbine steamer for Newhaven-Dieppe service, built by Société Anonyme des Forges et Chantiers de la Méditerranée. Dimensions: Length between perpendiculars, 303 ft.; breadth, extreme, 36 ft. 1 in.; depth of promenade deck, 23 ft. 4 in.; load draft, 9 ft. 6 in.; displacement, 1596 tons.

Welded. Model Welded Ship (Le navire-atelier "S. A. F. No. 4"), M. Lebrun. Bulletin technique du Bureau Veritas, vol. 2, no. 8, Aug. 1920, pp. 154–157, 15 figs. Model ship, 66 ft. long, built at French shipyards. Results of comparative tests on riveted and welded plates.

[See also VENTILATION, Ships.]

SHIPS, CONCRETE

Advantages. The Question of Concrete Ships (La question des navires en béton armé), R. Tardieu. Revue de l'Ingenieur et Index technique, vol. 27, no. 1, July 1920, pp. 25–40, 7 figs. Urges construction of concrete ships in France. Arguments are presented in proof of reliability and advantages of such ships.

Hollow-Tile Construction. New Methods for the Construction of Reinforced-Concrete Ships (Neue Wege beim Bau von Eisenbetonschiffen), Martin Mertes. Beton u. Eisen, vol. 19, nos. 6 and 9–10, Apr. 8 and June 5, 1920, pp. 64–66 and 112–113, 9 figs. Suggests new method which differs from usual one mainly in that the walls and floor of ship are built of hollow tiles made from light concrete about 26 in. long and 13 in. wide.

Oil Tanker. Concrete Tanker Built of Separately Cast Cylinders. Eng. News-Rec., vol. 85, no. 9, Aug. 26, 1920, pp. 388–393, 17 figs. Sections of two interlocked cylinders poured upright on platform and turned horizontally to be joined together to make 2000-ton oil carrying self-propelled vessel.

SHIPBUILDING

Germany. Development of German Shipbuilding with Special Consideration of Cargo-Ship Construction (Die Entwickelung des deutschen Schiffbau unter besonderer Berücksichtigung des Frachtdampferbaues), H. Dressel. Schiffbau, vol. 21, nos. 33, 34, 35, 37 and 38, July 7, 14, 21, Aug. 4 and 11, 1920, pp. 897–902, 931–934, 958–962, 1007–1012 and 1038–1042. Investigation of the economic causes for the English superiority in shipbuilding up to period of war and the American development during war, which are then considered from standpoint of their application to German shipbuilding, and ways and means for a more favorable development of German cargo-steamer construction are suggested.

SHIPYARDS

Europe. Shipbuilding in Europe, James J. Pearson. Pac. Mar. Rev., vol. 17, no. 9, Sept. 1920, pp. 107–108, 4 figs. Observations on conditions in British and continental shipyards.

Slipway Haulage Machinery. 800-Ton Electric Slipway Machinery at Southampton. Eng., vol. 110, no. 2851, Aug. 20, 1920, pp. 246 and 255, 7 figs. Slipway haulage machinery for raising vessels out of water. Single-drum design driven by reversible continuous-current motor. Cradle which travels up and down slipway is made in four positions coupled together, each portion having an independent sheave block.

SHOP COMMITTEES

Advantages of. Laying the Cards on the Table, Fred H. Colvin. Am. Mach., vol. 53, no. 12, Sept. 16, 1920, pp. 531–532, 2 figs. Advantages of shop-committee system established at plant of White Motor Co., Cleveland, Ohio.

Working in Practice. Serious Labor Problems in Cleveland, George Smart. Iron Age, vol. 106, no. 9, Aug. 26, 1920, pp. 515–517. Practical demonstration of working of shop committees.

SIPHONS

See AQUEDUCTS, Reinforced Concrete.

SPARK PLUGS

Insulators. Methods of Measuring Resistance of Insulators at High Temperatures, F. B. Silsbee and R. K. Honaman. Aerial Age, vol. 11, no. 24, Aug. 23, 1920, pp. 806–809, 11 figs. Report on preliminary experiments made on conductivity of spark-plug insulators in order to develop satisfactory comparative method for testing various materials. Measurements were made at temperatures between 200 deg. and 900 deg. cent. and with both alternating and direct current at voltages as high as 2000 volts. Report No. 53 of Nat. Advisory Committee for Aeronautics.

Visible Ignition. A Visible Ignition Spark Plug, and Another with an Air-Cooled Central Electrode. Auto, vol. 25, no. 36, Sept. 2, 1920, p. 921, 2 figs. Leda ignition plugs. Central electrode is hollow and is fitted at top with cup-shaped terminal and massive cap containing circular window of transparent material.

SPRINGS

Helical. Application of Equations of Elasticity to the Deformations of a Helical Spring (Sur l'application des équations de l'élasticité aux deformations d'un ressort en hélice), M. Galbrun. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 2, July 12, 1920, pp. 91–93.

Testing Machine. Spring Scragging Machine. Eng., vol. 110, no. 2851, Aug. 20, 1920, pp. 242–244, 4 figs. System adopted for applying scragging tests to springs embodying motor-driven variable rotary oil pump on Hele-Shaw principle. Arrangement permits obtaining about 40 complete strokes of tup per minute.

SPROCKET WHEELS

Cast-Steel, Machining of. The Machining of Large Cast Steel Sprocket Wheels, H. Varley. Eng. & Indus. Management, vol. 4, no. 9, Aug. 26, 1920, pp. 260–263, 9 figs. Discusses difficulties in machining of cast steel where large production is undertaken, and explains how big output was gained in connection with important detail of Mark V tanks without employing gear-cutting machine.

STANDARDIZATION

Industrial. Engineering and Industrial Standardization. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 544–545. Review of standardization work now in progress, both in this country and abroad, as reported by Am. Eng. Standards Committee and foreign standardizing bodies.

STANDARDS

See SCREW THREADS, National Screw Thread Commission.

STEAM

Flow in Pipes. Flow of Steam Through Pipes and Fittings, M. C. Stuart and M. H. Russell. Jl. Am. Soc. Naval Engrs., vol. 32, 3, no. Aug. 1920, pp. 472–480, 5 figs. Charts constructed from Carpenter formula.

STEAM HOSE

Construction. Construction of Steam Hose. Ry. Mech. Engr., vol. 94, no. 8, Aug. 1920, pp. 519–520. Experimental comparative study of relative values of seamless and plied tubes, and of simple duck and duck supplemented by braiding. Steam hose made with seamless tubes was found superior in endurance under steam pressure to hose with tubes made up of successive plies of sheeted stock. Hose with plied tubes was found to fail by splitting and separation of seam necessarily formed at surface of tube in its construction. Steam hose with fabric constructed of successive plies of frictioned duck proved superior in endurance to, and practically equal in expansion and contraction of, hose made of fewer number of plies of duck supplemented by plies of braiding.

STEAM POWER PLANTS

Shipyards. Ten-Thousand Horsepower Station for Operating Shipyard, Julius G. Berger. Power, vol. 52, no. 8, Aug. 24, 1920, pp. 284–289, 8 figs. Combined 5000-kva. turbo-alternator and 4500-hp. air-compressor plant. New plant built around old station while latter was kept in operation. Steam header 590 ft. long and main air line 2315 ft. long has butt-welded connections. Acceptance test data and performance are given.

Tests. Steam Power Plant Tests—III, H. L. Doolittle. Jl. Electricity, vol. 45, no. 4, Aug. 15, 1920, pp. 182–183, 1 fig. Charts showing results of simultaneous readings of pressures on steam and oil headers and also pressures of steam and oil at burner.

STEAM TURBINES

Balancing, Testing of. Leveling Micrometer for Testing the Balancing of Turbines. Eng., vol. 110, no. 2850, Aug. 13, 1920, p. 210, 2 figs. Designed and manufactured by Cambridge and Paul Instrument Co., Ltd., of Cambridge, London.

Governors for. Isodrome Governors (Ueber Isodrom-Regler), H. Kröner. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 28, July 1, 1920, pp. 529–531, 11 figs. Describes device, use of which in connection with direct- and indirect-acting engine governors, permits the elimination of the otherwise necessary speed difference between full load and no load. Use of isodrome governors for various types of steam turbines is discussed.

Operation and Adjustment. Operation and Adjustment of Turbine Machinery, Eustis H. Thompson. Power, vol. 52, nos. 8 and 10, Aug. 24 and Sept. 7, 1920, pp. 297–298, 16 figs., and 389–390, 1 fig. Troubles encountered in operation of turbine machinery are discussed, such as accumulation of coat of scale on blades, loss of balance of machine, shaft packing, etc.

[See also MARINE STEAM TURBINES.]

STEEL

Arsenic in, Effect of. Effect of Arsenic in Steel, P. E. McKinney. Chem. & Metallurgical Eng., vol. 23, no. 7, Aug. 18, 1920, p. 294. Static testing disclosed that 0.3 arsenic is not injurious. It is observed, however, that arsenic is extremely hard to get rid of after it is once present in steel and that if steel used for scrap purposes after its usefulness has ceased, there is a constant automatic augmentation of arsenic content which will in time get beyond limits desired.

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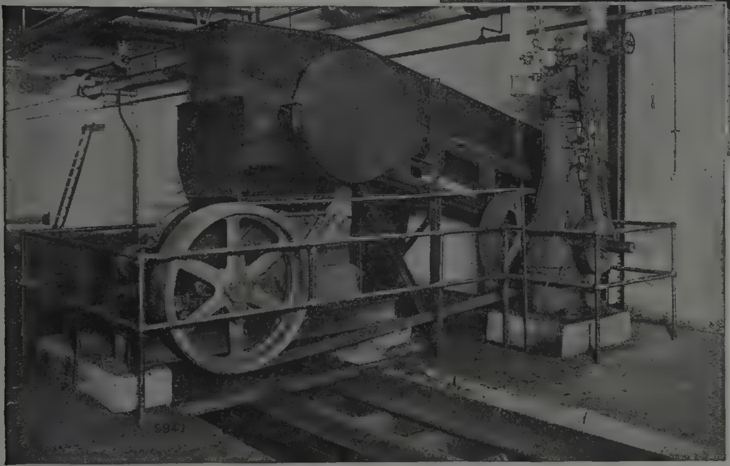

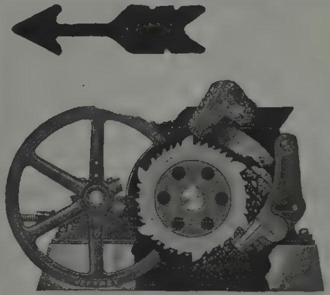

Top Illustration—Upper run of a Jeffrey 24 in. x 24 in. Pivoted Bucket Carrier at the new power plant of the Solar Refining Co., Lima, Ohio. It handles about 70 tons of crushed coal per hour to bunkers.

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Lower Illustration—In the basement of the Solar Refining Company's power plant showing the Jeffrey 30 in. x 30 in. Single Roll Crusher, fed by a steel apron from beneath a track hopper, which insures a uniform product to the carrier for the stokers.

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ENGINEERING INDEX (Continued)

Cast, Macrostructure of. Studies of the Macrostructure of Cast Steel, Fred G. Allison and Martin M. Rock. Chem. & Metallurgical Eng., vol. 23, no. 9, Sept. 1, 1920, pp. 383–389, 25 figs. Procedure is outlined for development and record of macrostructure. It is observed that symmetrical arrangement of dendrites is necessary for consistent physical tests, and it is pointed out that pouring cold metal suppresses dendrites.

German Trade. German Steel Trade Still Struggling. Iron Age, vol. 106, no. 12, Sept. 16, 1920, pp. 748–749. Lower prices fail to stimulate business. Concentration movement is more pronounced. Shipyards short of material.

High-Carbon, Welding. Difficulties in Welding High-Carbon Steel, G. H. Higgens. Am. Drop Forger, vol. 6, no. 8, Aug. 1920, pp. 387–388, 3 figs. It is shown that welding high-carbon steel tends to weaken part welded. Photomicrographs are presented illustrating actual structure of spring steel and patch after operation.

Magnetic Properties. The Variation of Residual Induction and Coercive Force with Magnetizing Force, R. L. Sanford and W. L. Cheney. Scientific Papers of Bur. of Standards, Dept. of Commerce, no. 384, June 23, 1920, pp. 291–298, 6 figs. Graphs and tables giving magnetic properties of steels of various compositions.

Open-Hearth. Effect of Time at which Silicon is Added on the Physical Properties and Gas Content of Open-Hearth Mild Steel (Der Zeitpunkt der Siliziumzugabe in seiner Wirkung auf die physikalischen Eigenschaften und den Gasgehalt von Martin-Flusseisen), E. Piwowarsky. Stahl u. Eisen, vol. 40, no. 23, June 10, 1920, pp. 773–781, 5 figs. Results of experiments show that high temperature is favorable in the tapping of basic silicated Martin charges to a separation of the silicates present as reduction product; the ferrosilicon addition should be made as late as possible as it reduces considerably the gas content of the finished product in liquid, solid and rolled condition.

Properties at High Temperatures. Properties of Iron and Steel at High Temperatures, A. E. White. Jl. of Am. Steel Treaters Soc., vol. 2, no. 10, Sept. 1920, pp. 521–528, 8 figs. Photomicrographs of steels of different compositions at high temperatures. Graphs of physical characteristics of various steels at high temperatures, constructed from data obtained by various experimenters, notably, H. J. French at United States Bur. of Standards.

Tempering. Influence of Cooling Speed on the Temper of Carbon Steels (Influence de la rapidité du refroidissement sur la trempe des aciers au carbone), A. M. Portevin and M. Garvin. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 132, no. 3, May-June 1920, pp. 297–346, 25 figs. Experimental. It was found in part that when temperature decreases uniformly, formation of troostite takes place at about 650 deg. cent. and martensite is formed slowly at about 300 deg. cent. Increasing speed of cooling lowers point of transformation, but not regularly. Conclusions are formulated in regard to significance of critical tempering speed. (Concluded.)

Tests on Tempering Certain Grades of Steel, Carl T. Hewitt. Iron Age, vol. 106, no. 11, Sept. 9, 1920, pp. 639–640, 4 figs. Effect of temperatures and time in hardening and drawing operations in final hardness of carbon tool, ball bearing and high speed steels.

Testing. Testing Steel, W. G. Lottes. Jl. of Am. Steel Treaters Soc., vol. 2, no. 10, Sept. 1920, pp. 537–541, 6 figs. Endurance testing of heat-treated and non-heat-treated, punched and drilled bars. Punched average 131 per cent better than drilled; plain showed gain of 100 per cent over punched; plain heat-treated compared 108 per cent with non-heat-treated; drilled treated 95 per cent over drilled non-treated.

[See also ALLOY STEELS; CHROME STEEL; CHROME-NICKEL STEEL; CUTTING METALS, City Gas vs. Acetylene; STEEL, HIGH-SPEED.]

STEEL CASTINGS

Light. Light Steel Castings, R. J. Dunderdale. Eng., vol. 110, no. 2849, Aug. 6, 1920, pp. 167–168. Causes of failures in light steel castings.

STEEL, HEAT TREATMENT OF

Automobile Drive Shafts. Heat Treating Automobile Drive Shafts. Iron Age, vol. 106, no. 11, Sept. 9, 1920, pp. 636–637, 3 figs. New plant of Timken-Detroit Axle Co. Furnaces have flues in doors. Waste gases used for pre-heating.

Flakes, Cure of. Cure of Flakes by Proper Heat Treatment, C. S. Crouse. Chem. & Metallurgical Eng., vol. 23, no. 8, Aug. 25, 1920, pp. 329–332, 5 figs. Account of heat treatment practice evolved for heavy nickel steel forgings which is said to have reduced flaky test bars to 15 per cent of total, based on idea that most flakes are caused by internal strains in metal.

Forging Temperatures, Effects of. Effects of Forging Temperatures on the Heat Treatment of Steel, Dana R. Cornell. Jl. of Am. Steel Treaters Soc., vol. 2, no. 10, Sept. 1920, pp. 529–537, 6 figs. Experiences had to do with chemical and physical requirements for tubes of 1918 model of 155 mm. Howitzer (Schneider), and record of events during forging, annealing, quenching and temper drawing of typical heat selected from several observed. Comparison of tests and of disposition of forging after each series of tests.

Hardening and Tempering. The Hardening and Tempering of Metallurgical Products (La trempe et le revenu des produits metallurgiques), L. Guillet. Revue générale des Sciences, vol. 31, nos. 14 and 15, July 15 and 30, 1920, pp. 432–441 and 473–487, 38 figs. Relations between theory of alloys and phenomena of hardening. (To be continued.)

Relation of Fuel and Furnace. The Relation of Fuel and Furnace to the Heat Treatment of Steel, R. P. Maynard. Jl. of Am. Steel Treaters Soc., vol. 2, no. 10, Sept. 1920, pp. 544–547. Advises against using more than four nozzles for heating furnace, and also against "pepper-box" or "honeycomb" type of nozzle.

Rifle and Machine-Gun Barrels. Heat Treatment of Rifle and Machine Gun Barrels, Arthur W. Green. Proc. Steel Treating Research Soc. and Jl. Am. Steel Treaters Soc., vol. 2, no. 12, 1920, pp. 25–30, 9 figs. Process as developed in plant which during war heat-treated rifle and machine-gun barrels in quantity practically without rejection.

Temperatures for. Temperatures for Heat Treating Carbon Steels, F. L. Moister. Jl. of Am. Steel Treaters Soc., vol. 2, no. 10, Sept. 1920, pp. 542–544. Following rule is formulated from results obtained from experience. Heat slowly to 1450 deg. fahr., hold at that point until thoroughly heated and quench in freely circulating water; draw 950 deg. to 1000 deg. fahr. if elastic limit of 55,000 lb. is required, and 1000 to 1050 deg. fahr. if elastic limit of 50,000 lb. per sq. in. is required.

STEEL, HIGH-SPEED

Hardening of. The Hardening of High-Speed Steel, A. H. d'Arcambal. Jl. of Am. Steel Treaters Soc., vol. 2, no. 10, Sept. 1920, pp. 498–520, 22 figs. Experiments conducted to determine effects of various hardening methods on hardness, microstructure and cutting efficiency of high-speed steel.

STEEL INDUSTRY

Germany. Large German Steel Companies Combine. Iron Age, vol. 106, no. 6, Aug. 5, 1920, pp. 333–334. Reports completion of deal between Gelsenkirchen and Deutsch-Luxemburg.

[See also IRON INDUSTRY.]

STEEL MANUFACTURE

Costs. Comparing Costs of Steel Making, E. H. Ballard. Foundry, vol. 48, no. 354, Sept. 1, 1920, pp. 697–698. Statement of cost covering operation during four months of 20-ton acid open-hearth furnace and 6-ton basic electric furnace are compared and discussed. Paper read before Am. Foundrymen's Assn.

Open-Hearth, Basic. Making Basic Open-Hearth Steel, C. W. Veach. Iron Trade Rev., vol. 67, no. 3, July 15, 1920, pp. 178–179. Overcoming slag inclusions. Results of slag tests on basic steel.

STEEL WORKS

Gary, Ind. Gary Works Expanded Fifty Per Cent During War, Gilbert L. Lacher. Iron Age, vol. 106, no. 12, Sept. 16, 1920, pp. 699–710, 13 figs. Additions consists of two coke-oven batteries, four blast furnaces, duplex plant, wheel works, and blooming, sheet and merchant mills.

STOKERS

Low-Grade Fuel-Burning. The Development of the Pluto Stoker for Utilization of Low-Grade Fuels (Die Entwicklung des Pluto Stokers für Verwertung minderwertiger Brennstoffe), Otto Nerger. Stahl u. Eisen, vol. 40, no. 29, July 22, 1920, pp. 969–975, 8 figs. Describes improvements of Pluto stoker, including hollow grate bar with removable sectional tops, spring-tightened side walls, adjustable suspension grate, and operation by "water column" motor. Results of experiments are given.

Underfeed. New Heavy Duty Underfeed Stoker. Can. Manufacturer, vol. 40, no. 9, Sept. 1920, pp. 50–52. Jones automatic-cleaning underfeed stoker manufactured in Canada by Underfeed Stoker Co. of Canada, Toronto. Manufacturers claim that it will effect guaranteed fuel saving of at least 10 per cent.

STORAGE BATTERIES

Operation and Care. Operation and Care of Vehicle-Type Batteries. Circular of Bur. of Standards, Dept. of Commerce, no. 92, June 7, 1920, 94 pp., 51 figs. Bulletin prepared with coöperation of Construction Division of Army, War Department. Glossary is included.

STOVES

Reinforced-Concrete. A New Patented Reinforced-Concrete Heating and Cooking Stove (Heiz- u. Kochofen aus Eisenbeton D.R.G.M. 730–790), A. Kern. Gesundheits-Ingenieur, vol. 43, no. 24, June 12, 1920, p. 280, 3 figs. Because of its thick walls it is practical in summer for cooking and heating food without overheating room, whereas in winter when well stoked it provides adequate heat and serves at the same time for cooking, keeping food warm and for supplying hot water for household purposes.

STREET RAILWAYS

Cars, Safety. Accidents Lessened by Safety Cars, W. H. Burke. Elec. Ry. Jl., vol. 56, no. 10, Sept. 4, 1920, pp. 457–459. Statistics from group of Stone & Webster properties in widely separated section of country. Accidents on basis of car-mile or passengers carried have been less with safety cars than with two-man cars. Other statistics given.

Jitney Buses vs. The Survival of the Fitter. Elec. Ry. Jl., vol. 56, no. 9, Aug. 28, 1920, pp. 412–414, 2 figs. Experience at Terre Haute, Ind. Jitney buses have dropped from 200 to 43 and have been forced to 10-cent fare during period when trolley cars have more than doubled in number and stayed at 5 cents in face of enormous increase in private automobiles.

Service-At-Cost Franchise. Cincinnati Director Reports. Elec. Ry. Jl., vol. 56, no. 10, Sept. 4, 1920, pp. 454–456, 3 figs. Report of first full year under Cincinnati service-at-cost franchise.

Track Paving, Cost of. How Cities of New York State Defeated Efforts of Street Railway Companies to Escape Cost of Car Track Paving, William P. Capes. Mun. and County Eng., vol. 59, no. 2, Aug. 1920, pp. 44–48. It is said that a nation-wide movement has been started by street-railway companies to repeal or modify laws and franchises requiring street railway companies to construct and maintain pavement between, and certain distance on either side of their tracks. Summary of argument which cities in New York State used before State Legislature in opposition to bill presented at last session is given.

STREETS

Two-Level. Chicago's New Two-Level Marginal Way, James Roland Bibbins. Eng. World, vol. 17, no. 3, Sept. 1920, pp. 167–171, 5 figs. Improvement design to connect Michigan boulevard two-level bridge plaza, elevation 33.5 and 15.5 with Market Street and with west side bridges. Upper level street 110 ft. in width is coördinated with level of north river bridges, 21 ft., and lower level 135 ft. wide with dock level, 5 ft., 25 ft. being devoted to wharfage.

STRESSES

Recoverance. Stress Results within Elastic Limit. Iron Age, vol. 106, no. 11, Sept. 9, 1920, pp. 649–651, 2 figs. Recoverance is defined as capacity of material to return immediately the energy that has been imparted to it by any external force. Instruments for obtaining property are described and data on tests of different materials included.

STUCCO

Tests. Tests on Panels of Wood and Stucco at Omaha. Eng. World, vol. 17, no. 3, Sept. 1920, pp. 179–180, 3 figs. Diagram showing stiffness of stucco as tested before Omaha Committee.

SUBMARINE SIGNALING

Sound Signaling. The Development and Present Status of Submarine Sound Signaling (Entwicklung und heutiger Stand des Unterwasserschall-Signalwesens), H. Lichte. Zentralblatt der Bauverwaltung, vol. 40, no. 39, May 15, 1920, pp. 249–253, 2 figs. Account of development of the electromagnetically excited sender for fog signaling and other purposes, and its importance in navigation. Includes chart showing range of submarine sound signals.

The Most Economical Sender Frequency for Aerial and Submarine Sounding Stations in Connection with Sound Reception (Ueber die ökonomischste Senderfrequenz für Schallanlagen in Luft und unter Wasser bei Gehörempfang), F. Aigner. Zeitschrift für Physik, vol. 1, no. 2, 1920, pp. 161–173, 1 fig. Investigation to determine what tone pitch of sender traversing a given distance effects the least consumption of radiating energy in the case of direct reception and with regard to absorption of receiver in the case of indirect reception.

SUBMARINES

Future Naval Warfare and. The Submarine and Future Naval Warfare, W. S. King-Hall. Jl. Royal United Service Instn., vol. 65, no. 458, May 1920, pp. 360–375 and (discussion), pp. 375–379. Developments expected during next ten years are thought to be as follows: battle-fighting ship will not be given submarine qualities; cruisers intended for observation work off enemy ports will be of submarine type, as also cruisers watching areas in which it may be necessary to shadow enemy fleet and those employed on guerre-de-course; cruisers employed against these raiders will be of aerial and submarine type working in conjunction.

German. German Submarines (Les sous-marins allemands), M. Laubeuf. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, vol. 73, nos. 1–2–3, Jan.-March 1920, pp. 27–64, 34 figs. partly on 3 supp. plates. Submarines, it is said, proved serviceable for coast protection and reconnaissance work. It is urged that three types be built in France; cruisers of 900 tons, coast guards of 500 tons, and mine layers of 500 tons.

[See also INTERNAL-COMBUSTION ENGINES, German Submarines.]

SUBSTATIONS

Automatic. First Automatic Industrial Substation, S. G. Leonard. Elec. World, vol. 76, no. 9, Aug. 28, 1920, pp. 417–420, 5 figs. Motor-generator set of 1500 kw. is installed at load center and automatically takes load when voltage drops. Automatic features are expected to reduce operation cost, give improved service and reduce light load losses.

SUBWAYS

Stations, Grouting of. Leaking Subway Station Successfully Grouted, M. H. Freeman. Eng. News-Rec., vol. 85, no. 7, Aug. 12, 1920, pp. 314–318, 3 figs. Inflow of more than 150 gal. per min. through broken joints in waterproofing checked by grout injection through pipes tapping leaking points.

SULPHURIC ACID

Manufacture. Manufacture of Sulphuric Acid by the Chamber Process, M. Kaltenbach. Chem. Age (N. Y.), vol. 28, no. 8, Aug. 1920, pp. 295–301, 2 figs. Statistics on production, temperatures, yields and consumption of raw materials are pre-

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ENGINEERING INDEX (Continued)

sented and analysis is made of these figures by striking thermal balances. Conclusions are derived, and modifications are suggested to remove defects of process. Translated from Chimie et Industrie.

SUPERHEATERS

Tests. Nickel Plate Power Plant at Conneaut, J. S. Morris. Ry. Mech. Engr., vol. 94, no. 8, Aug. 1920, pp. 537–539, 4 figs. Results of tests of superheater installation in stationary boilers.

SWITCHBOARDS

See ELECTRICAL APPARATUS, Testing.

T

TAYLOR SYSTEM

Mnemonic Classification. The Mnemonic System of Classification, H. K. Hathaway. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 173–183, 13 figs. Method as used in Taylor system of management. Reason for and advantages of mnemonic classification in industry and examples showing how system is applied and used.

TELEGRAPHY

Earth-Current. Earth-Current Telegraphy, L. C. Carus-Wilson. Bul. Int. Ry. Assn., vol. 2, no. 7, July 1920, pp. 422–431, 9 figs. Methods developed by armies for communication with troops at front. From Roy. Engrs. Jl.

TERMINALS, MARINE

Bulk Cargo Handling. Bulk Cargo Handling on the Atlantic Coast. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 740–743, 3 figs. Wellman-Seaver-Morgan unloader. Leg is so mounted in walking beam that it can rotate in circle, allowing bucket to reach out in all directions. Machine can unload 97 per cent of cargo without help of shovelers.

Economical Construction and Equipment. Quays More Economical Than Piers for Comprehensive Port, F. T. Chambers. Eng. News-Rec., vol. 85, no. 12, Sept. 16, 1920, pp. 556–558, 3 figs. Urges economical construction and equipment of marine terminals and their coördinate economic management.

Inefficiency, Cost of. The Cost of Inefficiency at Our Terminals, Harwood Frost. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 768–769. Writer estimates an annual waste of not less than $400,000,000 at American terminals due to inefficient equipment and methods. He indicates way in which it can be eliminated.

TERMINALS, RAILWAY

Columbus, Ohio. Up-to-Date Engine Terminal Management. Ry. Rev., vol. 67, no. 10, Sept. 4, 1920, pp. 345–356, 33 figs. Description of intensive operations and facilities therefor at Pennsylvania terminal at Columbus, Ohio.

Freight, Municipal. Municipal Freight Terminals, O. W. Stiles. Ry. Rev., vol. 67, no. 7, Aug. 14, 1920, pp. 233–235. Suggestion is offered as means of making present rolling stock adequate to needs of present-day transportation requirements, that each municipality assume financial and operating responsibility for its own terminals, leaving roads with more definite transportation duty and less of business duty to perform.

TERRA COTTA

Grog Grain, Effect of Size. The Effect of the Size of Grog Grain in a Terra Cotta Body, H. E. Davis. Jl. Am. Ceramic Soc., vol. 3, no. 8, Aug. 1920, pp. 641–652, 7 figs. It is concluded from results obtained experimentally that to develop good strength, both burned and dry, grog ingredient should contain rather large amounts of fine material as coarser material cracks and thus weakens body.

TESTING MACHINES

Bending Tests. Dynamic Tests of Metals by the Vibroflectometer (Essais dynamiques des métaux par le vibroflectométre), H. Lepape. Technique Automobile et Aérienne, vol. 2, no. 109, second quarter 1920, pp. 43–45, 4 figs. Patented machine for quantity testing.

Foundry. Testing Machines as Related to the Foundry, Thorsten Y. Olsen. Am. Mach., vol. 53, no. 12, Sept. 16, 1920, pp. 525–530, 13 figs. Survey of recent types, notably standard level type Brinell hardness-testing machines, hydraulic type Brinell hardness-testing type, automatic and autographic torsion machine, universal efficiency testing machine, Matsumura repeat-impact testing machine, and Norris slip-abrasion testing machine.

Hardness Testing. New Hardness Testing Machine has Wider Range of Action. Automotive Manufacturer, vol. 62, no. 5, Aug. 1920, pp. 20–21, 4 figs. Rockwell machine. Test is made by forcing alloy steel point under constant pressure into work under test.

Paper Strength. New Tearing Machine Measures Strength of Paper. Paper, vol. 26, no. 26, Sept. 1, 1920, p. 11, 1 fig. Recent development by Forest Products Laboratory makes duplicate tears in several sheets at once. Operations by means of a pendulum.

[See also SPRINGS, Testing Machine.]

TEXTILE INDUSTRY

Machinery. The British and Foreign Textile Machinery Industry. Eng., vol. 110, no. 2850, Aug. 13, 1920, p. 209. Tables of exports of textile machinery from Great Britain from 1913 to 1920.

THERMOCOUPLES

Common Metals. The Usefulness of Thermocouples of Common Metals for High-Temperature Work (Ueber die Brauchbarkeit von Thermoelementen aus unedlen Leitern in hohen Temperaturen), Fr. Hoffman and A. Schulze. Electrotechnische Zeitschrift, vol. 41, no. 22, June 3, 1920, pp. 427–433, 4 figs. A number of thermocouples, even at temperatures of 1000 to 1200 deg. and after a 100 hr. or longer period of heating gave results correct within about 10 per cent; the different nickel-chromium alloys, the carbon tube and the 66 per cent nickel steel especially gave evidence of great resistivity. The results obtained are so tabulated that they can be applied to determination of similar elements.

Electrically Deposited. Electrically Deposited Thermo-Couples. Engr., vol. 130, no. 3373, Aug. 20, 1920, p. 143, 7 figs. Number of turns of constantan wire were wound upon ebonite rod and immersed in copper plating bath so that half circumferential surface of rod was above level of liquid. Wire was then plated, thus forming sheathing of copper on each turn for approximately half its length. When junctions along one side of cylinder were heated above temperature of those on opposite side contrivance behaved as thermopile having large number of junctions in series.

THERMOELECTRICITY

Currents in Mercury. Thermoelectric Currents in Mercury (Ueber thermoelektrische Ströme in Quecksilber), H. Haga and F. Zernike. Annalen der Physik, vol. 61, no. 8, May 4, 1920, pp. 753–760, 1 fig. Results of experiments, in authors' opinion, refute existence of effect sought by Benedicks, and it is therefore not necessary to alter present theory of thermoelectricity. Report from Physical Inst. of Groningen University.

TIDAL POWER

Utilization. Economical Utilization of Tidal Power (Un moyen économique d'utiliser la force des marées), G. Bigourdan. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 4, July 26, 1920, pp. 211–212. Idea is suggested of utilizing tidal power by means of bell into which air is compressed during flow and a suction established during ebb.

TIME STUDY

Foundries. Time Study Underlies Bonus System, H. E. Diller. Foundry, vol. 48, no. 354, Sept. 1, 1920, pp. 682–686, 5 figs. Methods used for determining standard time for different foundry operations and forms used for recording amount of each kind of stock on hand and being consumed at foundry of Saginaw Malleable Iron Co.

Power Shovel. Time Studies for a Power Shovel, Daniel J. Hauer. Eng. and Contracting, vol. 54, no. 7, Aug. 18, 1920, pp. 168–170, 2 figs. Forms used

Rate Setting. Time and Job Analysis in Management—VI, William O. Lichtner. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 201–207, 2 figs. Possibility is pointed out of employing analyst jointly by employers and employees to secure facts in regard to industrial disputes and reaching a just decision. Reference is made to agreements worked out in garment making industry of New York City in support of this contention.

TIN PLATING

Alkaline Tin Baths. Tin Plating from Alkaline Tin Baths by the Use of Addition Agents, Frank C. Mathers and William H. Bell. Thirty-eighth General Meeting of Am. Electrochemical Soc., Sept. 30 to Oct. 2, 1920, paper no. 6, pp. 41–44. Balsam copaiba, rosin, and to lesser extent, other similar organic fatty acids or acid-containing substances were found to be successful addition agents in producing smooth, adherent deposits of tin from sodium stannite baths.

TIRES, RUBBER

Substitutes for. Substitute for Rubber Tires (Ersatz für Kautschukreifen), H. Jahr. Kunststoffe, vol. 10, nos. 5 and 6, Mar. 1 and 2, 1920, pp. 49–53 and 64–66, 18 figs. Details of composite bristle, fiber, felt, hair, paper and pasteboard tires, as well as of tires made of mixtures of asphalt, bitumen, concrete, cellulose, wood pulp and similar materials.

TOOL-GRINDING MACHINES

Automatic. New Automatic Universal Machine for Sharpening Tools of Lathes, Planing Machines, Slotting Machines, etc. (Nouvelle machine automatique et universelle à affuter les outils de tour, raboteuses, mortaiseuses, etc.), Serge Heranger. Ouvrier Moderne, vol. 3, no. 1, April 1920, pp. 24–28, 5 figs. Description of S. H. D. machine. (Concluded.)

TOOLS

Cutting Edges of. Cutting Edges, R. E. Crompton. Eng., vol. 110, no. 2852, Aug. 27, 1920, p. 292. Table indicating angles for cutting edges of tools or other cutting appliances. Paper read before Eng. Section, British Assn. for Advancement of Science.

TOWN PLANNING

Transportation and. City Building and Transportation, James Rowland Bibbins. Jl. Western Soc. Engrs., vol. 25, no. 12, Aug. 20, 1920, pp. 411–459 and (discussion), pp. 459–469, 25 figs. Technical relationships involved, with reference to conditions in large American cities.

TRACTOR ENGINES

Burt Sleeve-Valve. The Burt Single Sleeve-Valve Petrol Engine. Engr., vol. 130, no. 3372, Aug. 13, 1920, pp. 154–156 and p. 158, 7 figs. Manufactured by Wallace Farm Implements, Ltd., Cardonald, Glasgow, for its "Glasgow" tractor and other agricultural appliances. Sleeve is disposed between piston and walls of cylinder barrel and projects down into interior of crank case where it is formed on one side with pair of flanges. Link engaging between flanges connects sleeve to short-throw crankshaft in such a way that as valve shaft rotates sleeve rotates backwards and forwards through small arc and at same time rises and falls vertically

TRACTORS

Bull Gears. Discussion of Materials for Tractor Bull Gears, W. H. T. Thornhill. Automotive Industries, vol. 43, no. 12, Sept. 16, 1920, pp. 570–573. In plea for better tractor, writer takes up problem of blanks for transmission and discusses in turn advantages and handicaps of cast iron, cast semi-steel, cast steel, forged steel and rolled steel. Each material is discussed from service and construction viewpoint.

Case. Case Designs Production Machines for Unit Frames, P. M. Heldt. Automotive Industries, vol. 43, no. 12, Sept. 16, 1920, pp. 562–568, 12 figs. Outstanding feature of Case farm tractors is "unit" frame casting which also serves as bottom half of engine crankcase, bottom half of transmission case and rear axle housing. Special machines built to perform major operations on this crane casting are described and illustrated.

Design. Tractor Weight and Drawbar Pull, A. F. Moyer. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 232–234, 4 figs. Design considerations for selecting ratio of tractor weight to drawbar pull in any given case.

Plowing-Speed Tests. Ottawa Beach Plowing-Speed Tests. Jl. Soc. of Automotive Engrs., vol. 7, no. 3, Sept. 1920, pp. 274–276, 7 figs. Tests were conducted to determine most desirable tractor speed for plowing.

[See also CONNECTING RODS, Machining.]

TRADE UNIONS

Legal Status. Legal Status of Trade Unions (Le status légal de nos syndicats ouvriers), Léon-Mercier Gouin. Revue Trimestrielle Canadienne, vol. 6, no. 22, June 1920, pp. 163–175. Urges that trade unions and collective bargaining be officially recognized by federal statute, trade unions to be considered as civil corporations.

TRANSFORMERS

Bushing and Housing. New Type of Transformer Bushing and Housing. Power, vol. 52, no. 10, Sept. 7, 1920, p. 360, 2 figs. Type of bushing and housing for outdoor transformers of moderate voltage approved by Inspection Dept. of Associated Factory of Mutual Fire Insurance Companies.

TRANSPORTATION

Highway, Theory of. The Development of an Economic Theory of Highway Transportation, Robert C. Barnett. Eng. & Contracting, vol. 54, no. 9, Sept. 1, 1920, pp. 201–205, 6 figs. Formulæ for cost of roadway, motive power and vehicle elements in determining cost of transportation giving annual tonnage between fixed points.

Land, Germany. German Land Transportation (Das deutsche Verkehrswesen), Karl Trautvetter. Archiv für Eisenbahnwesen, no. 3, May and June, 1920, pp. 382–412. Review of the historical development of land and water highways, aerial traffic and the railroads, with special consideration of electric railway transportation and its proposed adoption on the future German national railroads Includes discussion of development of steam railroads in Europe, America, Asia, Africa and Australia, the status of Germany in international commerce and her economic and commercial status at the end of the war.

TUNNELS

Vehicular. Bridge Versus Tunnel for the Proposed Hudson River Crossing at New York City, J. A. L. Waddell. Proc. Am. Soc. of Civil Engrs., vol. 46, no. 6, Aug. 1920, pp. 943–947, 1 fig. Costs are estimated to be: For highway bridge $32,500,000; for four highway tunnels $49,000,000; for electric-railway bridge, $34,500,000; for four double-track electric-railway tunnels, $48,000,000; and for eight single-track, electric-railway tunnels, $30,000,000.

TURBO-BLOWERS

See BLOWERS.

TYPEWRITERS

Manufacture of. Operations in the Manufacture of Typewriters. Machy. (Lond.), vol. 16, nos. 412, 413 and 414, Aug. 19, 26 and Sept. 2, 1920, pp. 610–616, 643–647 and 675–677, 32 figs. Description of methods used by Imperial Typewriter Co., Ltd., Leicester, England.

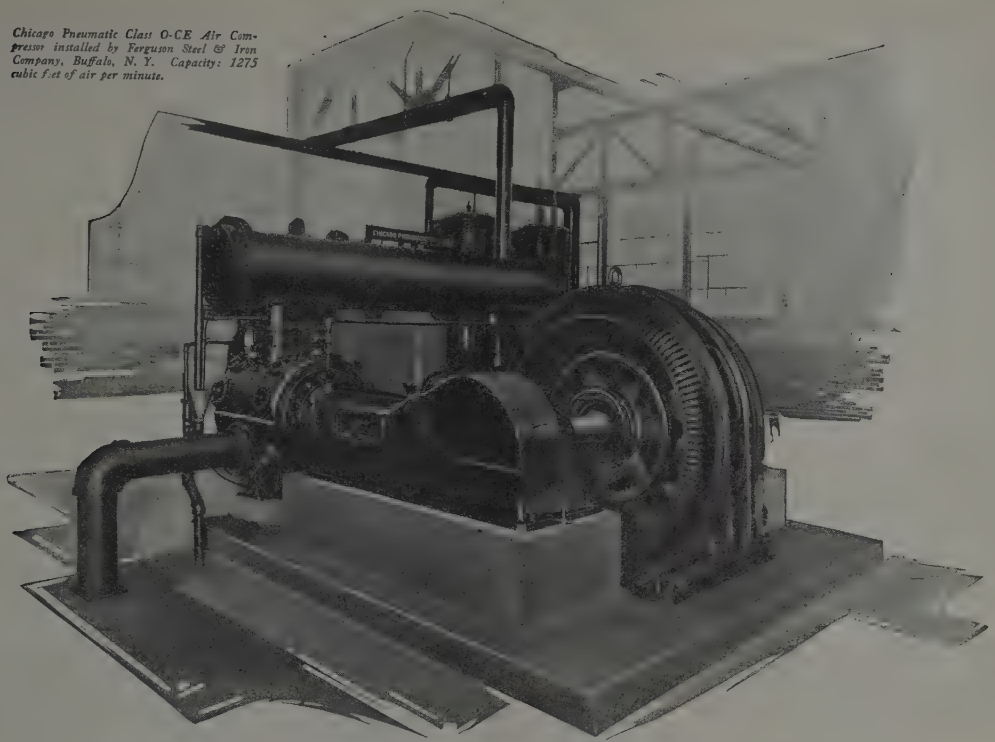
V

VACUUM

High, Production and Measurement. The Production and Measurement of High Vacua—III, Saul Dushman. Gen. Elec. Rev., vol. 23, no. 8, Aug. 1920, pp. 672–683, 13 figs. Description of Gaede's diffusion pump, Langmuir's condensation pump, and others of mercury-vapor type. Remarks relative to care and operation of exhaust equipment are given in appendix.

VACUUM TUBES

Spectroscopic Phenomena. An Extension of the



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CHICAGO CHICAGO CP PNEUMATIC PNEUMATIC

The Compressor with the Simplate Valve

ENGINEERING INDEX (Continued)

Balmer Series of Hydrogen and Spectroscopic Phenomena of Very Long Vacuum Tubes, R. W. Wood. Proc. of Roy. Soc., vol. 97, no. 687a, Aug. 3, 1920, pp. 455–470, 8 figs. partly on 2 supp. plates. Photographs of 8 additional lines in Balmer series.

[See also ELECTRON TUBES.]

VALUATION

Industrial Equipment. Reconciling Depreciation and Appraised Values of Industrial Equipment, Lester G. Hawkins. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 207–209, 2 figs. Reference is made to instances in which in computing federal income and excess profit taxes, wide discrepancies have resulted between book values of industrial equipment obtained through process of regular depreciation and appraised values of same equipment ascertained by engineering survey. Reasons for these variations are discussed and bases upon which just reconciliation can be worked out are suggested.

VENTILATION

Ships. Ventilating Systems, G. A. Bisset. Int. Mar. Eng., vol. 25, no. 9, Sept. 1920, pp. 720–724, 3 figs. partly on supp. plate. Graphic method of determining sizes of mains and ducts for mechanical ventilation. Calculations are based on General Specifications of U. S. Navy using coefficient of friction for ordinary piping of 0.0001.

VENTURI FLUMES

Open-Channel Measurements. A Study of the Venturi Flume as a Measuring Device in Open Channels, P. S. Wilson and C. A. Wright. Eng. News-Rec., vol. 85, no. 10, Sept. 2, 1920, pp. 452–457, 6 figs. Experimental work at Cornell Hydraulic Laboratory to obtain data for more rational design of venturi flumes. Loss of head in venturi flume much less than in weir of same capacity range.

VIBRATIONS

Gravity-Elastic. Variably Coupled Vibrations: Gravity-Elastic Combinations—II. Both Masses and Periods Unequal, L. C. Jackson. Lond., Edinburgh, and Dublin Philosophical Mag. and Jl. Sci., vol. 40, no. 237, Sept. 1920, pp. 329–342, 4 figs. Mathematical theory of coupled system consisting of gravity and elastic pendulum is developed for general case, in which masses and periods of two pendulums are both unequal.

W

WAGES

Germany, Wartime. Wages in Germany During the War, Alfred Maylander. Monthly Labor Rev., vol. 11, no. 1, July 1920, pp. 116–128, 3 figs. From reports of German factory and mine inspectors for years 1914 to 1918.

Increase with Cost of Living. Keeping Workers Contented with Two-Pay Envelopes, Frank C. Hudson. Am. Mach., vol. 53, no. 6, Aug. 5, 1920, p. 249. Plan which automatically takes care of advance or decline in cost of living based on Bradstreet's reports. It leaves basic wages as before and meets increased costs of living by special payments.

Payment, System of. Systems of Paying Wages (Étude sur les salaires), Ch. Beun. Outillage, vol. 168, no. 32, Aug. 12, 1920, pp. 490–492, 6 figs. Formulæ for determining wages in the various systems. Comparison of systems.

Systems. Comparison of Wage Incentive Systems and the 100 Per Cent Time Premium, L. V. Estes. Indus. Management, vol. 60, no. 3, Sept. 1920, pp. 210–217, 3 figs. Exposition of 100 per cent time premium wage system developed and applied by writer.

Tests. Rigidity Tests on Various Types of Wall Construction Made by Omaha Building Department. Am. Architect, vol. 118, no. 2329, Aug. 11, 1920, pp. 199–200, 4 figs. Six different types of panels were tested. Diagrams are given showing distortion of panels under test.

WALLS

Concrete, Heat Transmission Through. The Stability of Thin Walls, and Heat Transmission Through Thin Walls. Concrete and Constructional Eng., vol. 15, no. 8, Aug. 1920, pp. 530–532. Advanced publication of report of Building Materials Research Committee under Dept. of Sci. Indus. Research. Tests showed that concrete walls as thin as $2^5/_8$ in. can safely be used for partitions in cottage building, even when supporting joists. Of walls tested, rough ballast concrete offered least resistance and 10-in. concrete cavity unventilated wall with inner partition of coke breeze offered greatest resistance to flow of heat.

WARSHIPS

Design. The Design of War Vessels as Affected by the World War, David Watson Taylor. Jl. Franklin Inst., vol. 190, no. 2, Aug. 1920, pp. 157–185, 13 figs. It is estimated that present tendency is toward increased size and cost, but it is believed that this very tendency, under present financial, economic and political conditions in the world, may actually result in disappearance from future problems of these types, substitution for them of smaller and cheaper units being made possible by new developments in science and engineering.

WASTE HEAT

Utilization of. Exhaust-Steam Storage Plant with Utilization of Waste Heat for Low Pressure Steam Turbines (Abdampfspeicher mit Abhitzeverwertung für Niederdruck-Dampfturbinen), H. Schömburg. Wirtschaftsmotor, no. 5–6, May-June 1920, pp. 21–22, 3 figs. Describes new type of heat-storage plant with double-pressure turbine, by use of which it is said to be possible to effect with a minimum of cost a drying and superheating of the exhaust steam.

The Generation of Steam through Utilization of Waste-Steam Heat (Dampferzeugung durch Abwärmeverwertung), Ernst Blau. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 23 and 24, June 4 and 11, 1920, pp. 169–170 and 178–180, 6 figs. Refers to recent installations in a number of plants for utilization of waste heat which have given satisfactory service, and gives detailed description of the MAN waste-heat steam boilers with removable boiler-tube nests.

WATER FILTRATION

Experiments. Water Filtration Experiments and Devices, Joseph W. Ellms. Public Works, vol. 49, no. 10, Sept. 4, 1920, pp. 215–218, 6 figs. In studying purification of Lake Michigan water, writer experimented with mixing channels, fish ladder, "flume" and "fall," and concluded that coagulation could be effected more cheaply and just as effectively by one of smaller devices as by large coagulation basin. Devices and results are described.

Toledo, Ohio, Plant. Collapse of Basin Wall and Roof at Toledo. Eng. News-Rec., vol. 85, no 12, Sept. 16, 1920, pp. 537–539, 3 figs. Following rapid filling of sendimentation basin at Toledo, Ohio, water filtration plant 350-ft. length of concrete baffle wall, 12 in. thick collapsed carrying with it 54 panels of concrete roof slab and 16 columns. Repair methods are explained.

WATER GAS

Plants. Gas Plant at Providence, Wm. Russell. Gas Industry, vol. 20, no. 8, Aug. 1920, pp. 201–206. Water-gas plant with capacity of 3,500,000 cu. ft. per 24 hr.

WATER HAMMER

Calculation of. Calculation of Water Hammer in Conduits Formed of Two or Three Sections of Different Diameters (Calcul du coup de bélier dans des conduites formées de deux ou de trois tronçons de diamétres différents), Ed. Carey. Bulletin Technique de la suisse romande, vol. 46, no. 13, June 26, 1920, pp. 145–149, 1 fig. Comparative study of formulæ. (Concluded.)

[See also CONDUITS, Air Chambers in.]

WATER POWER

Development in U. S. Water Power Development in the United States, Henry J. Pierce. Nat. Elec. Light Assn. Bulletin, vol. 7, no. 8, Sept. 1920, pp. 569–575, 3 figs. Total available potential horsepower is estimated at 61,678,000. Present development is about 6,000,000 hp. Power upon which development is expected to be begun under new water-power act amounts to 2,122,000 hp.

Permits and Licenses. Regulations Governing Water-Power Permits and Licenses. Elec. World vol. 76, no. 12, Sept. 18, 1920, pp. 568–569. Regulations governing application for and granting of water-power permits and licenses under recently passed water-power bill formulated by Federal Power Commission.

WATER PURIFICATION

Mixing of Coagulating Chemical Solutions. Novel and Economical Mixing Devices for Applying Chemical Coagulant to Water Recommended after Tests at Milwaukee, Joseph W. Ellms. Mun. and County Eng., vol. 59, no. 2, Aug 1920, pp 67–69. Device suggested by writer after conducting extensive experiments on purification of water supply of Milwaukee, Wis.

Ozonization. Ozonization of Water (L'ozonisation des eaux d'alimentation), M. Bousquet. Vie Technique et Industrielle, vol. 1, no. 7, Apr. 1920, pp. 30–34, 7 figs. Van der Made system.

WATER SOFTENING

Continuous Lime-Soda Type. Data on Operation of Continuous Type Lime-Soda Ash Water Softener, R. F. Catherman and H. C. Fisher. Chem. & Metallurgical Eng., vol. 23, no. 11, Sept. 15, 1920, pp. 526–528, 5 figs. Information obtained during operation of Booth continuous water softener for a period of six months, 16 hr. per day.

WATER SUPPLY

Metered Systems, Records of. Water Use Variation in Completely Metered Systems, Allen Hazen. Eng. News-Rec., vol. 85, no. 10, Sept. 2, 1920, pp. 449–450, 3 figs. Data from Springfield, Mass., Hartford, Conn. and Superior, Wis.

Railway Systems. Railway Water Supply at Atkins, Iowa, Fred D. Yeaton. Eng. News-Rec., vol. 85, no. 10, Sept. 2, 1920, pp. 463–464. Electric pumps at river supply 300,000 gal. daily by 5-mile main to terminal. Test of surge in long pipe line.

WATERWAYS

Great Lakes-Ocean. The St. Lawrence River Project, Horace C. Gardner. Mech. Eng., vol. 42, no. 9, Sept. 1920, pp. 509–512 and p. 527, 2 figs. Economical advantages of Great Lakes-Ocean waterways.

[See also CANALS.]

WELDING

Boiler Repairs. Repairs to Boilers by Welding. Eng. & Indus. Management, vol. 4, no. 8, Aug. 19, 1920, pp. 234–235, 2 figs. Regulations enacted by Nat. Boiler & General Insurance Co., Ltd., Manchester for use and information of its inspectors and of firms insuring their machinery under companys policy. Rules refer to both electrical and gas welding.

Gears and Pinions. The Art of Welding Gears and Pinions, F. H. Sweet. Am. Drop Forger, vol. 6, no. 9, Sept. 1920, pp. 452–454. Advisability of welding each tooth separately or of welding several teeth en bloc. Selection of proper welding tip and filler rod.

[See also ELECTRIC WELDING; ELECTRIC WELDING ARC; OXY-ACETYLENE WELDING; STEEL, High-Carbon Welding.]

WELFARE WORK

Technical Institute for Employees. Ford Technical Institute to Better Education of Employees. Motor Age, vol. 38, no. 10, Sept. 2, 1920, p. 26. University plans to confer degrees in mechanical, electrical and chemical engineering.

[See also HOSPITALS, Shop.]

WELLS

Percolation. The Analysis of Yield Tests Made on a Percolation Well. Eng., vol. 110, no. 2852, Aug. 27, 1920, pp. 272–273, 2 figs. Analysis of yield tests made on experimental well sunk into water bearing, decomposed and disintegrated granite soil in order to ascertain if locality was suitable for obtaining supply of water sufficient for water supply of small town in South India.

WINCHES

Electric. Efficiency in Electric-Winch Design, Sv. Fasting. Motorship, vol. 5, no. 9, Sept. 1920, pp. 812–815, 3 figs. Diagrams showing relative values of winch with standard type of dynamic breaking and winch equipped with Shepard automatic mechanical load brake.

WIRES

Elastic Limits of Copper, Bronze and Iron. Elastic Limits of Copper, Bronze and Iron Wires (Sur la limite d'élasticité des fils de cuivre, bronzes et fer), Société belge des Électriciens, Bulletin mensuel, vol. 34, no. 3, July 1920, pp. 127–129. Values measured at State research laboratories at Malines, Belgium.

WOOD

Allowable Stresses. Douglas Fir as a Structural Timber. Can. Engr., vol. 39, no. 11, Sept. 9, 1920, pp. 317–318. Table of working stresses adopted by various authorities, such as Department of Railways and Canals, Canada, Am. Ry. Eng. & Maintenance-of-way Assn., etc.

The Permissible Stresses for Wood According to the Prussian Building Regulations (Ueber die zulässige Beanspruchung des Holzes nach den preussischen Hochbauvorschriften), A. Senft. Zentralblatt der Bauverwaltung, vol. 40, no. 36, May 5, 1920, pp. 223–224. Gives regulations of Dec. 24, 1919, limiting permissible bending and tensile strength for oak and pine to 100 kg. per sq. cu. m. and pressure stress to 80 and 60 kg. per sq. cu m. respectively, which writer finds too stringent.

Cellulose in Determination of. Some Observations on the Determination of Cellulose in Woods, S. A. Mahood. Jl. Indus. & Eng. Chem., vol. 12, no. 9, Sept. 1920, pp. 873–875. Experiments to investigate effect of size of particle on yield of cellulose. Material which passes an 80-mesh standard (Am.Soc.C.E.) sieve but is retained on 100-mesh sieve was found to be most satisfactory from standpoint of both yield and manipulation.

Distillation. Recent Developments in the Hardwood Distillation Industry and Suggestions for the Future, L. F. Hawley. Chem. & Metallurgical Eng., vol. 23, no. 10, Sept. 8, 1920, pp. 466–468, 2 figs. Work on increase and variation of yields of pyroligneous products: acetate of lime, methanol and charcoal. Cord stocks cut into 5-in. blocks. Control of retorting temperatures. Central research organization.

Effects of Moisture on. Tests on the Action of Heat and Humidity on Structures of Hetzer Type (Essais sur l'action de la chaleur et de l'humidité sur les constructions du système Hetzer), A. Freymond. Bulletin technique de la Suisse romande, vol. 46, no. 15, July 24, 1920, pp. 169–170 and 174–175, 1 fig. Hetzer wooden structures employ special system of placing beams which somewhat resembles method used in metallic structures. They have been used for building of railway bridges by the Swiss Federal Railways. Hetzer system is described in Schweiz. Bauzeitung, no. 16, 1911.

Moisture, Effect of. Properties of Woods at 10 Per cent Moisture, B. C. Boulton and R. L. Hankinson. Aerial Age, vol. 12, no. 2, Sept. 20, 1920, pp. 43–44. Table showing properties of woods in terms of properties of spruce.

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Mechanical Engineering

A monthly journal containing a review of progress and attainment in mechanical engineering and related fields, The Engineering Index (of current engineering literature), and a summary of the activities, papers, and proceedings of

The American Society of Mechanical Engineers

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C 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Contributors and Contributions

U. S. Navy Gun-Forging Plant

The twenty-million-dollar Naval Ordnance Plant at South Charleston, W. Va., is not essentially a "war plant." It is a permanent Navy institution which will provide additional capacity for the manufacture of armor-plate and gun forgings at a lower price than that now paid to commercial manufacturers, and in which experiments can be carried on to improve the product and simplify manufacturing methods. Roger M. Freeman, supervising engineer in the design and construction of this plant, has prepared the first description of this notable work as a paper for the Annual Meeting. Before taking up this work Mr. Freeman was engaged in steel-mill construction at the Erie City Iron Works for the Navy Department. The paper presents the entire plan in broad outline and it is hoped that details of the various unusual features of the plant will be the subject of future papers for the Society.

Roger M. Freeman

Foundations for Machinery

N. W. Akimoff, of Philadelphia, Pa., the author of the Annual Meeting Paper entitled Foundations for Machinery, has been long connected with the development of machinery for the balancing of high-speed rotating elements. The present paper is an advance along somewhat different lines and is notable because of its new method of approach to the problem of foundations for machinery.

New Steam Formulas

R. C. H. Heck, professor of mechanical engineering at Rutgers College, has carried out an intensive study of the basic data and various formulas at present in use for the calculation of the properties of steam. Professor Heck has compared the various formulas and has derived a new series which it is believed will combine all points of value of the existing formulas. The Power Test Code Committee of the Society has had under consideration the preparation of standard steam tables for inclusion in the Power Test Code, and it is hoped that the discussion on this paper will form the basis for the formulation of such standard tables.

Rational Design of Hoisting Drums

At the request of manufacturers of hoisting drums, E. O. Waters, assistant professor of machine design, Sheffield Scientific School, Yale University, conducted a series of experiments from which a rational formula was developed for the thickness of flange and drum for use of hoisting-drum designers. Professor Waters utilized a special drum which permitted the side thrust against one flange to be measured while the rope was being wound on the drum.

Layout and Construction of Dye Houses

One of the papers to be presented at the session of the Textile Section at the Annual Meeting deals with the Organization and Construction of Dye Houses. In this paper, Mr. A. W. Benoit, of the office of Charles T. Main, Boston, Mass., takes up the location, construction, ventilation and piping of dye houses and the fundamental principles underlying the arrangement of buildings of this type and their equipment. The paper is illustrative of the special fields of activity covered by the newly organized Professional Sections, and the abstract published in the current number will be of very general interest to many members.

New York Meetings and Washington Meeting

One of the largest meetings ever held in the Engineering Societies Building, New York, occurred on October 22, for the discussion of the relative merits of steam and electric locomotives. This was under the auspices of the Railroad Section of the A.S.M.E., the Metropolitan Section of the A.S.M.E., and the New York Section of the A.I.E.E. Three comprehensive papers were presented, one in favor of the steam locomotive and two for the electric locomotive, after which there was a general discussion. In this number will be found a full report of the meeting.

Another meeting of broad interest, reported in this number, was the special meeting of the A.S.M.E. to commemorate the Fortieth Anniversary of this Society, at which there were reminiscences of the activities of the Society during its long existence, and three leading addresses having a forward look with regard to the opportunity and responsibility of the engineer. The mechanical engineer, dealing as he must with production problems, is vitally interested in determining the viewpoint of the financier, the manufacturer and the workman. Each of these elements was represented at the meeting by most capable speakers, and the addresses abstracted in this number are of such a character as to be helpful to engineers generally and to attract wide attention.

The supreme meeting of the past month, however, was the first meeting of the American Engineering Council of The Federated American Engineering Societies. It was attended by delegates from many organizations, who entered with enthusiasm into the work of establishing the engineers of the country on a firm basis of coöperation in such public activities as may need their concerted action. This meeting is also fully reported in this number.

1920 A.S.M.E. ANNUAL MEETING

Engineering Societies Building, New York, December 7–10, 1920

This issue of "Mechanical Engineering," in which a number of Annual Meeting papers are abstracted, should reach its readers shortly before the start of the meeting. Announcement of the events of the meeting was made in the November "Mechanical Engineering" and in a circular sent to the membership. A complete account of the meeting will be published in January.

MECHANICAL ENGINEERING

Volume 42 December 1920 Number 12

Armor-Plate and Gun-Forging Plant of U. S. Navy

A Description of the Government-Built and Operated Naval Ordnance Plant at South Charleston, W. Va.—"H"-Type Forge and Furnace Building Among Unique Features of Plant

By ROGER M. FREEMAN,[1] NEW YORK, N. Y.

The magnitude of such a project as the establishment of the Navy-owned, built and operated Naval Ordnance Plant at South Charleston, W. Va., has made it impossible for the author to give details on all points of the development of the plant. He describes briefly the establishment of the projectile plant and preliminary steps leading up to the actual construction of the armor-plate and gun-forging plant, a general description of which is the main object of the paper. The general layout of the plant and transportation facilities are covered and then the author passes to a more detailed discussion of the unusual features of design and construction. Among these are the arrangement of the stock yard alongside the open-hearth building, the 30-ton electric furnaces for duplexing, the electric traveling cranes to carry 400,000-lb. ingots, the original "H" type of forge shop and treatment plant combined, the 14,000-ton steam-intensified hydraulic press, the twenty 15-ft.-wide Carbottom furnaces, the machine shop with three 106-ft.-wide aisles, and the gun-treatment building, the high portion of which contains a 75-ton crane of 104-ft. span on rails 165 ft. above the floor level which serves a 10, by 105-ft. high electric treatment furnace placed in a concrete pit 55 ft. deep. The 23 electric traveling cranes, twenty of which are 75-ton or larger and three of 250 tons capacity, are discussed. The 25,000-kw. electric substations, the 6500-hp. boiler plant and the 25,000,000-gal. reservoir are also discussed briefly.

The paper concludes by summarizing the various steps in the development, outlining the organization of the project and personnel, giving in round numbers construction costs, and stating briefly the present status of work on the plant which is now substantially completed.

SEVERAL years ago the papers were again full of the historic discussion as to whether the Navy Department should attempt to manufacture armor plate for itself or continue to go to the three non-competing firms who were able to make armor in this country, and pay the price asked. With the strong backing of Secretary Daniels and Senator Tillman, and despite much opposition by the manufacturers, the public at large, and certain Navy circles, Congress directed that the plant be built. Shortly thereafter the war came on and the project was generally forgotten in the rush of ordnance manufacture for the nations of Europe and for this country, when we finally entered.

On August 30, 1917, ground was broken at South Charleston, W. Va. for the construction of a projectile plant as the first unit of the U. S. Naval Ordnance Plant. The main advantages of South Charleston lay in its being in the center of the rich coal districts of West Virginia, in the proximity of iron mines and blast furnaces, and in the availability of natural gas and oil. The reservation consists of somewhat over 200 acres of land located between the Chesapeake & Ohio Railroad and the Great Kanawha River about five miles below Charleston, at South Charleston, W. Va. It is divided into a north unit of approximately 40 acres and a south unit of approximately 160 acres, by Eighth Avenue, which is the main road and which carries the trolley line between Charleston and St. Albans.

The projectile plant, which occupies the north unit, was completed and put into operation in the spring of 1918, since when it has operated satisfactorily, producing principally 6-in. gun forgings, counter-recoil cylinders, 16-in. armor-piercing projectiles, air flasks for torpedoes, steel ingots up to 18 tons, and at the present time the entire demand of the Navy Department for armor bolts. The projectile plant cost about $2,000,000 and consists principally of a forge and foundry, approximately 130 ft. by 560 ft., containing three 6-ton Heroult electric furnaces, two 60-in. cupolas, a small brass foundry, a 3000-ton press and a 500-ton press, eleven forge and five regenerative Carbottom annealing furnaces; a machine shop, 140 ft. by 400 ft., completely equipped for machining minor-caliber gun forgings, large projectiles and general machine-shop work, and a heat-treatment shop, 92 ft. by 153 ft.

In June 1918 it was decided to vigorously push the construction of the main plant for the production of armor plate and major-caliber gun forgings. The writer was summoned from Erie, Pa., where he had supervised the construction of the Erie Forge and Steel Company and other steel plants for the Navy, and placed in charge of the design and construction. A designing and drafting force was built up around his engineering assistants from Erie and his previous work, and a half-dozen draftsmen who had worked on the projectile plant. During the summer of 1918 the layout and the general design for the main buildings were completed, and by November 1 were approved by the bureaus concerned.

It was decided that due to existing conditions in the material and labor markets, the impossibility of writing specifications and getting lump-sum bids without great delay, and on account of the general disrepute into which cost-plus contracts for Government plant construction had fallen, the work should be done directly by the Navy. A construction division was organized and construction work was under way by October 1, 1918.

The armor-plate and gun-forging plant has been designed to produce armor plate of the heaviest type, completely finished, ready to attach to battleships; and major-caliber gun forgings, up to 20-in., 50-caliber in size, rough-machined, which will be sent to the Washington Navy Yard for finish-machining. It will employ about 3000 when completed and in full operation.

The United States Naval Ordnance Plant is not a "war plant" in the modern usage of the term, but a permanent Navy institution which is abundantly justified for the following reasons:

First, additional capacity for the manufacture of armor plate and gun forgings has been provided.

Second, cost of armor manufactured by the Naval Ordnance Plant should be less to the Navy than the price now paid to commercial manufacturers and will afford a definite means of determining what the fair price for armor and gun steel to be paid steel manufacturers by the Navy should be.

Third, the Naval Ordnance Plant will be a large-scale experimental and research laboratory which can continually strive to improve the product and simplify manufacturing methods. In this connection it is interesting to note that the first group of 16-in. armor-piercing projectiles made at the Naval Ordnance Plant passed the test at Indian Head and that the plant is successfully making air flasks for torpedoes.

Fourth, a very great additional advantage in the Government-owned and operated plant is the fact that improvements in product or methods can, when desired, remain the property of the United States.

GENERAL LAYOUT

The general layout of the south unit was determined first by the requirements of manufacture in modern straight-line methods,

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[1] Supervising Engineer in charge during design and construction of Naval Ordnance Plant, Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 7 to 10, 1920, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

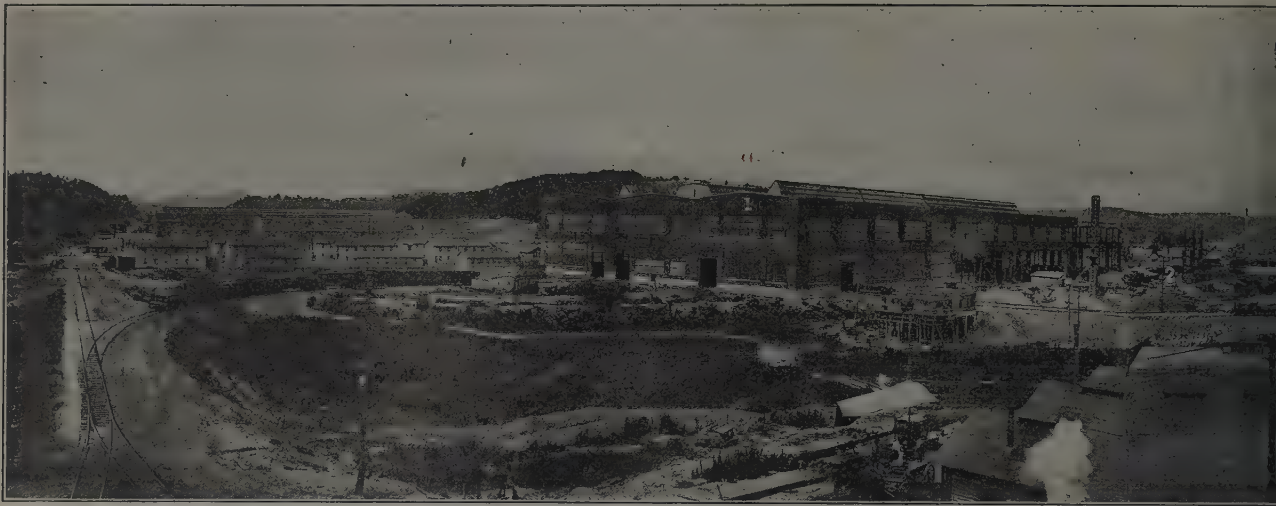

Fig. 1 The United States Naval Armor-Plate and Gun-Forging Plant at South Charles-
Buildings:[1] 1, Machine Shop; 2, Gun-Treating Building; 3, Forge and Furnace Build

and secondly by the topography of the site. Fig. 1 shows the general layout of the armor and gun-forging plant. The four main buildings, namely, the open-hearth, the forge and furnace, the machine shop, and the gun-treatment building are arranged in parallel on a shuttle track which runs at right angles to the major axes of the buildings and connects them all together. This track will be the backbone of the manufacturing processes. All main buildings have been placed so that future expansion to double the capacity of the plant may be readily made.

Scrap and pig iron will be received from the Chesapeake & Ohio Railroad, at the southeast corner of the reservation, sorted from other incoming material in the classification yard, and stored in the stock yard alongside the open-hearth building. Steel will be melted in the open-hearth furnaces, refined in the electric furnaces, and cast into ingots in the pouring pit in the open-hearth building. From there the ingots will be transferred to the forge and furnace building, by way of the shuttle track for heating, preparatory to forging into armor plate or guns under the presses located in the center of the forge and furnace building. The armor-plate forgings will then be carbonized, annealed, tempered, hardened, and ultimately sent over to the machine shop on the shuttle track where the armor plate will be machined and finished, ready for attaching to battleships. Gun forgings will be green-annealed in the south aisle of the forge shop, sent to the north aisle of the machine shop for rough-machining, and thence to the gun-treatment building for heat treatment prior to shipment to the Navy Yard in Washington for finish-machining and assembling.

The service building, which comprises the main electric substation, the air compressors, the water-supply distribution pumps, and the boiler plant, which provides steam for the steam-intensified hydraulic presses and for heating the machine shop, are located as nearly as possible to the center of gravity of their respective loads.

Twin buildings, one of which will be used for general stores and the other for the blacksmith shop, pattern and templet making and storage, have been located in the southeastern portion of the south unit accessible to the railroad system and the forge shop.

The maintenance shops, in which the electricians, pipefitters, riggers and carpenters, are to be located, and the locomotive repair shop and roundhouse, will be combined in one building at the approximate center of the reservation.

The western portion of the south unit as divided by the main railroad track running north and south, contains a large storage yard and the "skull cracker."

The reservoir and settling basin for the industrial water-supply system has been made by throwing two earth-filled dams across the western end of the gully which cuts diagonally across the reservation.

An administration building of sufficient size to house the executives for the entire ordnance plant was built at the same time as the projectile plant and located in the south unit on Eighth Avenue. The balance of the frontage on Eighth Avenue is occupied with temporary buildings for construction offices, stores, the garage, barracks to house about 1000 men on construction work, and Bungalow Park, in which 32 bungalows were erected for the occupancy of the supervisors of the construction division.

Type of Structure

In general, the buildings consist of a structural-steel framework, unusually heavy on account of the size of the cranes on concrete foundations, some of which contain upward of 200 cu. yd. of concrete enclosed by walls of specially designed hollow red-tile building block, 5 in. by 12 in. by 8 in. Fifty per cent or more of the surface area of the walls is steel sash. The roof decks are of gypsum composition, cast in place and covered by waterproof roofing. In round numbers about 50,000 cu. yd. of concrete has been placed in the various foundations, 25,000 tons of structural steel erected, and in excavation and grading upward of 500,000 cu. yd. of earth moved. The total area under roof is approximately 700,000 sq. ft. for the main buildings alone.

Transportation Facilities

It was evident very early in the design period that one of the most important features of the entire plant would be the arrangements for efficiently handling and moving unusually heavy and awkward loads. For example, one armor-plate ingot which will be made about six times a year will weigh upward of 400,000 lb., and tube forgings for the major-caliber guns will weigh up to possibly 100,000 lb. and run in length up to nearly 100 ft. An armor plate in the making must be handled something like fifty separate times and as the average weight of the finished plates is in the neighborhood of 50 tons, very special attention was required in the design of the electric traveling cranes and in the railroad-track system.

The railroad system, which totals something over seven miles in length, is outlined on Fig. 2. A classification yard of ten tracks including incoming and departure tracks has been provided. Pro-

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[1] In the background toward the north may be seen the projectile plant with the barracks for the construction forces in the foreground. In the immediate foreground is the main track crossing the upper dam of the reservoir. Immediately in front of the machine shop is the oxy-hydrogen building and gasometers in process of construction. To the right of the machine shop is the concreting plant for the gun-treatment pit, only a portion of the steelwork having been erected. The steelwork for the high portion, when completed, will reach a point three times the height of the adjacent parapet wall of the machine shop, i. e., somewhat over 200 ft., and somewhat higher than the twin chimneys for the boiler plant shown in the middle of the photograph. The fill for the shuttle track is shown leading from the forge shop to the south side of the machine shop. Note the open monitors on the low and high portions of the forge and furnace building. The photograph was taken from a position near the middle of the railroad "Y" which is at the approximate center of the reservation.

ton, W. Va.; View Looking in a General Eastwardly Direction, August, 2, 1920
ing; 4, Open-Hearth Building; 6, Boiler House; 7, Foundations for Service Building.

visions have been made for tracks entering into either end of practically every crane aisle. A complete loop-within-loop system has been developed so that a wreck or stoppage on any main track will not hold up the operation of the plant or of any individual major building. A three-way reinforced-concrete approach trestle will lead to the charging-floor level of the open-hearth building.

The major specifications of the twenty-three overhead electric traveling cranes are given in Fig. 3. Each main aisle of the four main buildings is provided with erecting girders for the cranes located in the roof trusses.

While by far the larger portion of the traffic at the plant will be by rail, a system of concrete roads 20 ft. in width has been developed in order to provide auto-truck service to all main buildings, and for employees. The main entrances to both the north and south units will be from Eighth Avenue, where the plant railway crosses. A central receiving building with a special siding has been built near this point as shown on Fig. 2, for the unloading of less-than-carload shipments and to permit distribution by auto truck.

Open-Hearth Building

The unusual features of the open-hearth at the Ordnance Plant consist of the arrangement of the stock yard alongside the building, the 100-ft.-wide pouring aisle with exceptionally heavy cranes, the arrangement for "duplexing" by placing the electric furnaces in the pouring aisle and the dump trestle and storage bins in the crane-served charging aisle.

Figs. 4, 5 and 6, inclusive, show the general arrangement and give the important dimensions of the building which, including the stock yard, is 331 ft. wide by 516 ft. long.

The charging floor of the open-hearth building has been designed to withstand a load of 800 lb. per sq. ft. It extends 30 ft. out under the crane runway of the stock yard to form a charging platform. Two parallel tracks are arranged upon this charging platform with cross-overs conveniently located, and a turn-out leads to the charge track directly in front of the open-hearth furnace doors.

A track connected at both ends to the main system runs through the stock yard at the ground level adjacent to the charging platform. Materials for the charge, such as scrap, pig iron, etc., received on this track can be unloaded directly by the stock-yard cranes by magnet and placed in charging boxes on charging cars on the charging platform. These cars will be made up into trains, each containing a complete charge for an open-hearth furnace, or the incoming cars of material may be unloaded directly into the stock piles. The charge train will be shifted by an electric storage-battery locomotive over the scale, located near the entrance to the charging aisle, directly to the track in front of the open-hearth furnace doors and into position for the charging machine to start charging the furnaces. The empty train of charging boxes will be shunted back to the charging platform over the same track it entered, or out of the building at the east on to the trestle and back.

The charging floor carries three tracks, two of standard gage which are connected into the three-way approach trestle at the east of the building, and the third of 24 ft. 6 in. gage for the low-type charging machine. The floor is paved with brick. The charging track is located directly in front of the furnaces and the so-called "hot-metal track" is at the far side of the aisle. This track originates in the approach trestle and continues at the east end of the building over a series of concrete bins arranged so that cars of material can be bottom-dumped. The track then leads to the main charging floor where it will be used for handling materials with which to repair the furnaces and thus avoid interference with operation.

Space has been provided for three 65-ton open-hearth furnaces, two of which are now being completed. An electric traveling crane of 25 tons capacity with an auxiliary hoist of 10 tons capacity serves the entire length of the charging aisle.

Underneath the charging floor and back of the open-hearth furnaces is the pit for the checker chambers enclosed by a reinforced-concrete retaining wall. The lean-to contains the offices, the quick-test laboratory, chimneys, storage areas, lockers, toilets, etc.

The pouring aisle is served by three electric traveling cranes, specifications for which are given in Fig. 3. The distance from the center to center of crane runway rails is 100 ft. Jib cranes of 6 tons capacity with a radius of 25 ft. are mounted on main building columns adjacent to the open-hearth furnaces for handling the spouts.

The unusual width of the pouring aisle was to give space in the open-hearth building for the storage and chipping of ingots, and on account of the large pouring pit in which it is planned to ash-anneal the ingots. The location of the electric furnaces for duplexing in this aisle was an important factor in determining this width.

The pouring pit is divided for convenience in operation into two levels and is of reinforced concrete lined with 13 in. of red brick. The lower level is 16 ft. below the floor, 30 ft. wide and 93 ft. long and the upper level is 8 ft. deep, 30 ft. wide and 46 ft. long.

For open-hearth steel the furnaces will be tapped into the ladles and carried directly to the pouring pit and bottom-poured directly into the ingot molds. In obtaining electric steel by duplexing, the open-hearth furnaces will be used simply for melting the charge, which will be tapped into ladles and then carried down the shop to charge the electric furnaces.

Two 30-ton Heroult electric furnaces have been erected as shown in Fig. 5 on independent concrete foundations, and are surrounded

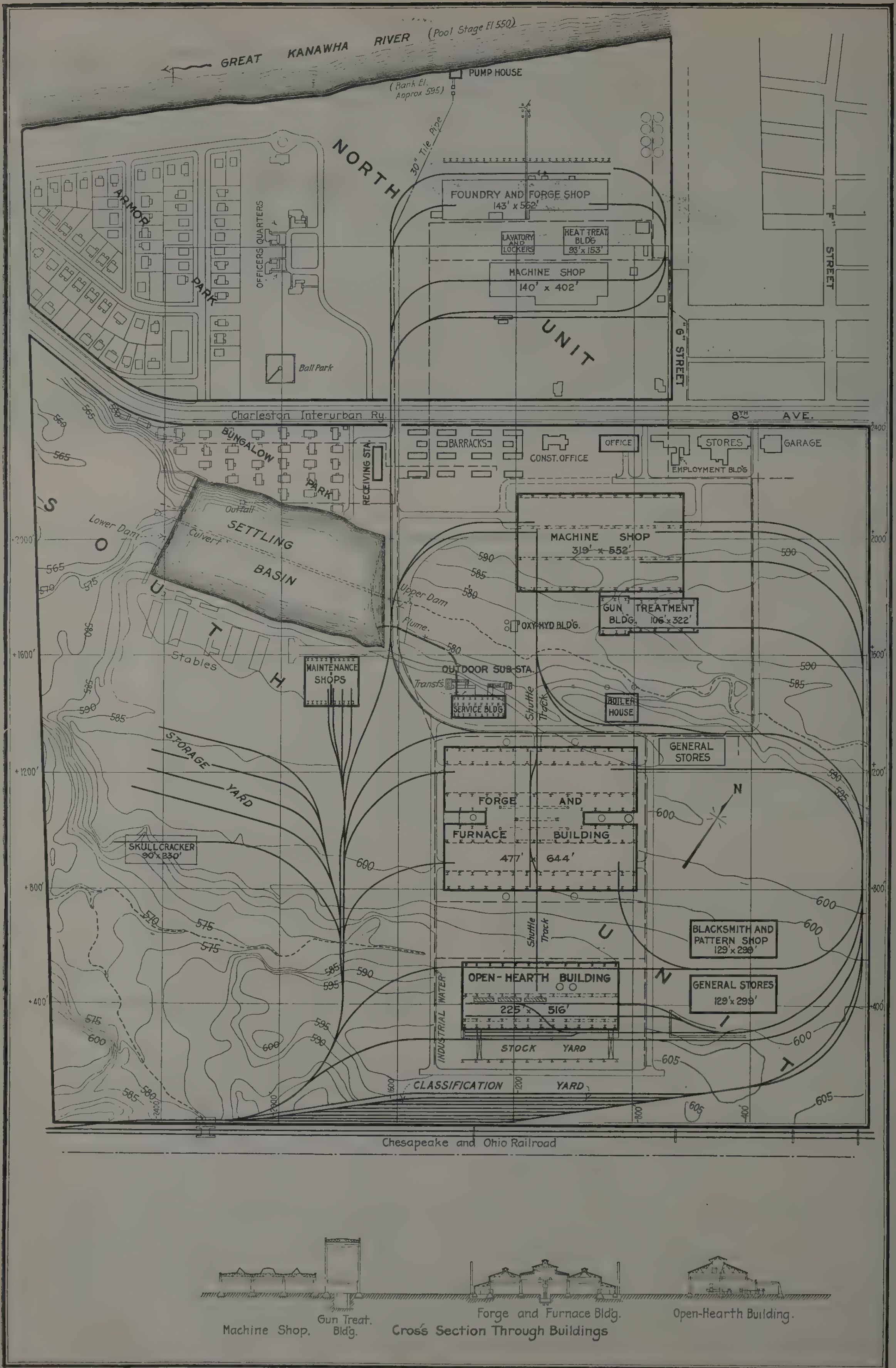
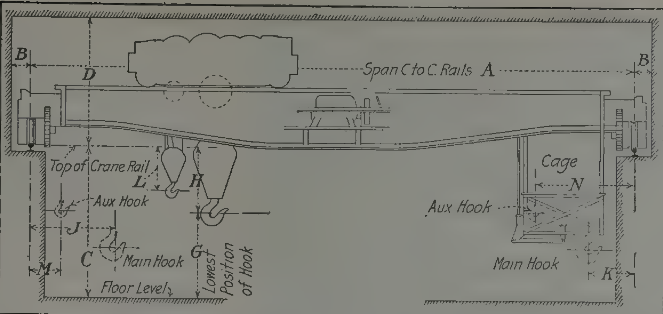


Fig. 2 General Layout of Plant Showing Track Plan

by a charging platform which is an extension of the charging floor and on which are placed the transformer houses. Flux material will be brought over to this floor from the bins in the charging aisle. The furnaces will be charged from the rear. The capacity of one open hearth is sufficient to charge the two large electric furnaces. After the refining process, a ladle will be brought close into the front of the electric furnace by lifting a large trap door, the furnace tilted forward and the contents discharged into the ladle, which will then be carried back to the pouring pit and the molten steel will be bottom-poured into ingots in the usual manner.

In casting the largest ingot, the open-hearth furnaces will be overloaded to 80 tons each and will be brought out at the same time as one or both of the 30-ton electric furnaces overcharged if required.

Tracks enter the pouring aisle at either end for a length of one or two car lengths and the south end of the shuttle track is at the middle of the building adjacent to the pouring pit, conveniently located for the transportation of ingots to the forge shop.



	OPEN-HEARTH CRANES					FORGE AND FURNACE BUILDING					MACHINE SHOP		HEAT TREATMENT	
CRANE NUMBER	1	2	3	4	5,6	7,8	9,10	11, 12	13, 14	15	16,17	18,19 20,21	22	23,24
LOCATION	O H POURING SLIDE	O H POURING SLIDE	O H POURING SLIDE	O H CHARGING SLIDE	STOCK YARD	MAIN AISLE	MAIN AISLE	PRESS ROOM		PRESS ROOM				
CAPACITY (NET TONS)														
MAIN HOIST	250	125	75	25	15	200	100	250	—	75	150	75	75	NO 21
AUXILIARY HOIST	40	25	15	10	NONE	25	25	25	—	15	25	15	NONE	
SPEED (FT PER MIN)														NO 20
MAIN HOIST	10	10	14	23	50	8	10	7		14	10	14	HOIST 50 LOWER 100	
AUXILIARY HOIST	20	23	30	30	0	23	23	30		30	23	30	0	NO 19
BRIDGE	200	200	200	250	300	200	200	150		200	200	200	100	
TROLLEY	75	75	100	150	150	75	100	50		70	100	100	50	NO 18
CRANE RAILS	175LB LORRAINE STEEL CO			80LB ASCE		175LB LS Co		2-175LB LS 2'-0" C TO C		175LB LORRAINE STEEL CO				
CLEARANCES														
A	100'-0"	100'-0"	100'-0"	80'-0"	100'-0"	100'-0"	100'-0"	70'-9"		70'-0"	100'-0"	100'-0"	104'-0"	SAME AS CRANES
B	1'-11¾"	1'-11¾"	1'-11¾"	1'-3¼"	1'-2"	1'-10½"	1'-10½"	2'-10"		2'-9"	1'-10½"	1'-10½"	1'-10½"	
C	55'-0"	55'-0"	55'-0"	54'-10¼"	39'-0"	40'-0"	40'-0"	46'-9"		78'-0"	40'-0"	40'-0"	165'-0"	
D	19'-0"	19'-0"	19'-0"	19'-1¾"	12'-0"	19'-0"	19'-0"	21'-0"		13'-6"	17'-6"	17'-6"	13'-6"	
G	53'-0"	40'-0"	43'-0"	53'-10¼"	38'-0"	37'-0"	38'-0"	25'-0"		78'-0"	37'-0"	38'-0"	165'-0"	
H	2'-0"	15'-0"	12'-0"	1'-0"	1'-0"	3'-0"	2'-0"	21'-6"		0'-0"	3'-0"	2'-0"	0'-0"	
J	8'-6"	7'-0"	7'-0"	6'-0"	3'-6"	9'-3"	7'-6"	3'-0"		7'-0"	8'-6"	7'-0"	10'-0"	
K	9'-0"	8'-0"	7'-0"	4'-0"	3'-6"	10'-0"	5'-0"	5'-0"		6'-0"	7'-9"	6'-0"	10'-0"	
L	0'-0"	0'-0"	0'-0"	0'-0"		0'-0"	0'-0"	26'-6"		0'-0"	0'-0"	0'-0"		
M	3'-6"	7'-0"	3'-6"	3'-6"		3'-6"	3'-6"	7'-0"		3'-6"	3'-6"	3'-6"		
N	14'-0"	6'-0"	6'-6"	6'-6"		15'-9"	9'-0"	7'-0"		9'-6"	12'-9"	9'-6"		
REMARKS		FOUR GIRDER LADLE CRANES			CAGE AT CENTER OF SPAN			HYDRAULIC HOIST TUMBLING BLOCK SPEED 6 FT PER MIN		VERTICAL LIFT			REMOTE CONTROL	

Fig. 3 Specifications for Electric Traveling Cranes

Attention is invited to the runway escape platform for the crane operators at the level of the bottom of the crane cages, also to the provision in the structural design for ventilation. The entire wall area of the building is left open to a distance 8 ft. above the ground, although arrangements are made for vertically lifting doors in case of severe weather. The sides of the large monitor are left entirely open and without louvers, high curbs being provided on the main roof and the overhang of the monitor roof being made excessive for protection against the weather.

Forge and Furnace Building

The design of the forge and furnace building of the U. S. Naval Ordnance Plant is believed to be a radical departure from anything that has been built for the purpose.

The forge shops of the existing armor plants consist of buildings with one main crane aisle and a lean-to on one or both sides. The furnaces are located in the lean-tos, the presses in the middle or at one end of the main aisle.

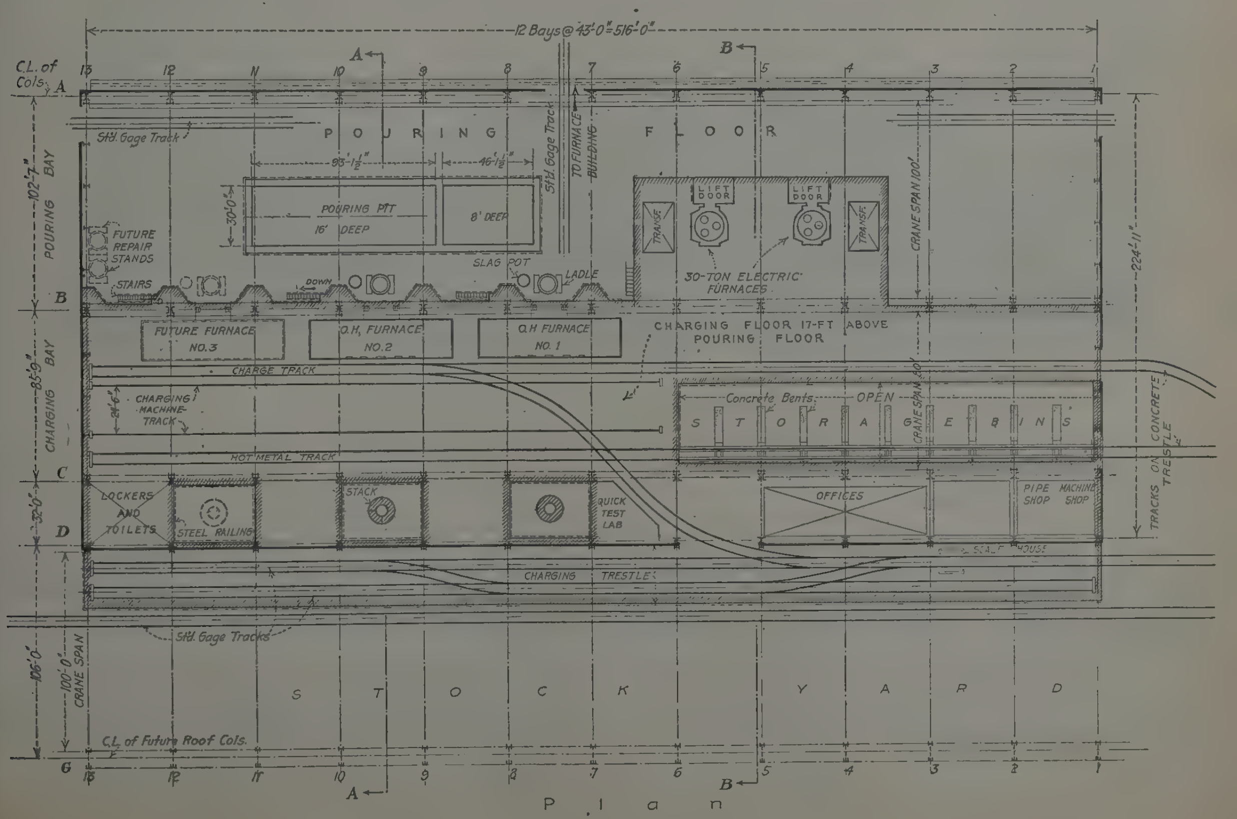


Fig. 4 Floor Plan of Open-Hearth Building

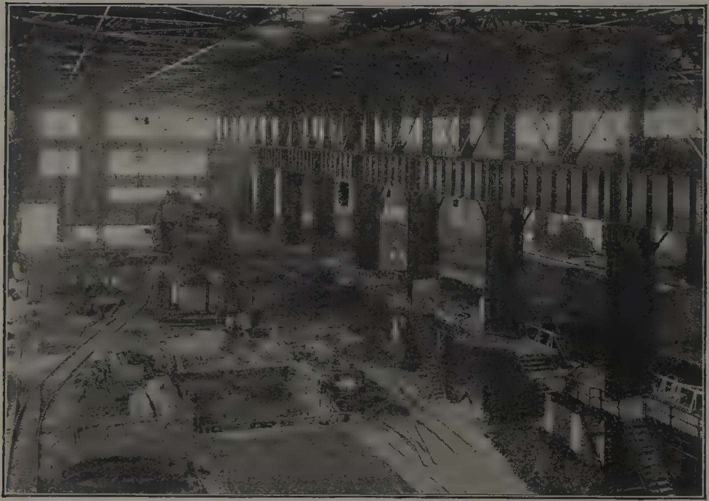


Fig. 5 Pouring Aisle of Open-Hearth Building Looking East from Crane Girder, July 14, 1920

Casting pit is in immediate foreground. Electric furnaces just beyond. Charging floor, when completed, will extend completely around furnaces. Locations for open-hearth furnaces 1 and 2 are shown to the right just behind middle row of columns. Box cars on charge track of charging aisle indicate scale. Crane span of charging aisle is 100 ft. wide.

Forging cranes are provided on either side of the press on crane rails which at one end of the span are supported on the top of the press and at the other end on separate steel structures. Forging heats are brought from the furnaces down the main aisle by the overhead cranes and placed in a position where they can be picked up by the forging cranes, although in certain cases the ingot furnaces are in direct reach of the forging cranes. In order that the presses and the forging cranes may be cleared, the overhead crane in the main aisle must be placed at a relatively great height above the ground. This makes an expensive building.

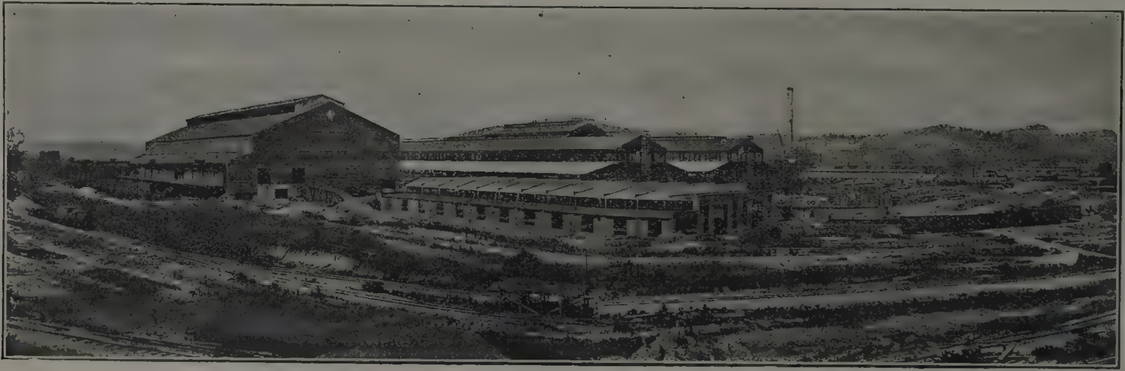


Fig. 6 Open-Hearth Building from Southeast, August 2, 1920

Alongside the Open-Hearth Building is the stockyard with 100 ft. crane span. Classification yard is to extreme left. Note track doors at charging-floor level. Three-way concrete trestle will replace temporary wooden trestle. In immediate foreground is general storehouse and blacksmith and pattern shop (No. 5). Twin buildings each 130 by 300 received through Army salvage.

The treatment shops of the existing armor plants are located in separate structures from the forge shops, and as plates must be returned to the press for bending, straightening, etc., considerable railroad traffic between the two buildings results, unless two very large presses are provided.

At the Naval Ordnance Plant the forge shop and the treatment shop for both armor plate and gun forgings have been consolidated in the "H"-type forge and furnace building. The general arrangement is shown by Figs. 7, 8, 9 and 10. The overall dimensions of the building are 644 ft. by 477 ft. The building consists of two main aisles, each of which has a lean-to on either side and which are connected by the press room which forms the cross-bar of the "H."

The 14,000-ton steam-intensified hydraulic forging press and its driving equipment, including the 2500-lb. hydraulic-pressure pumps, the 32-in. accumulator and the steam receivers and intensifiers, is located in the eastern half of the press room as divided by the shuttle tracks. (Fig. 11.) The 6500-ton press which will be erected in the future will be located in the western half.

The direction of the forging is from the south aisle toward the north aisle. A 250-ton hydraulic forging crane with an auxiliary hook of 25 tons capacity is located on either side of the press on double runway rails 46 ft. above the floor. The inside runway rails are supported directly on top of the press. These forging cranes, of which all the motions excepting the hoisting motions are electrically driven, have a sufficient range of bridge travel to pick up loads from either of the shuttle tracks. Water is supplied to the hoist motions from the pressure system at 2500 lb. per sq. in.

The entire area of the press room proper, which is approximately 140 ft. wide by 160 ft. long, has been made entirely free from columns except for the row necessary to support the inside crane runway rails for the forging cranes. The central area over the presses is served by a 75-ton crane located on rails approximately 80 ft. above the floor level. This crane has been placed to serve in the erection of the presses and of the forging cranes as well as in their repair. The span of the runway girders is 140 ft. The track scale of 600,000 lb. capacity is located on the main shuttle track in the northern half of the press room.

Briefly and generally the process for armor-plate manufacture in this building will be as follows: The ingot will be received in the south aisle from the open-hearth building on a flat car by way of the shuttle track. It will be lifted by an overhead crane and placed in one of the ingot furnaces by means of a porter bar. To heat the ingot will require up to 20 hr. The hot ingot will then be withdrawn from the furnace and carried down the aisle to either one of the shuttle tracks and deposited on a car which will then be pushed through the few feet necessary by an electric locomotive into the press room. It will be picked up by a forging crane and carried under the press.

The first forging operation will last about an hour. It will bring the plate down within an inch or so of its finished thickness and will include cropping the ingot. The plate, which is then 35 per cent lighter, is returned to the south aisle, deposited on the car of one of the Carbottom type reforging furnaces, which will then be rolled into the furnace and the plate will be reheated preparatory to reforging. After reforging and rectifying, the plate will come out into the north aisle for the carbonizing, annealing, tempering and hardening operations, and under normal conditions will not return again to the south aisle although returning occasionally to the press room, as required, for bending and straightening. It then goes via shuttle track to the machine shop.

The "H" type of building consolidating the forging plant with the treatment building presents the following main advantages:

(*a*) A low first cost. An estimated saving of half a million dollars was secured by keeping the height of the runway rails in the main aisles down to 40 ft.

(*b*) The maximum economy of space secured by consolidating the forge and treatment operations in one building.

(*c*) The maximum economy in operation should result, due to the compactness of the building itself, the relatively short haul from any furnace to the press room, and the time saved over present methods in operation.

(*d*) The presses are very accessible to the furnaces and any press can receive work directly from any furnace in either aisle.

(*e*) Operation of cranes in the furnace aisles will not interfere with or be interfered with by forging operations in the press room.

(*f*) Operating conditions are ideal in so far as light and ventilation are concerned.

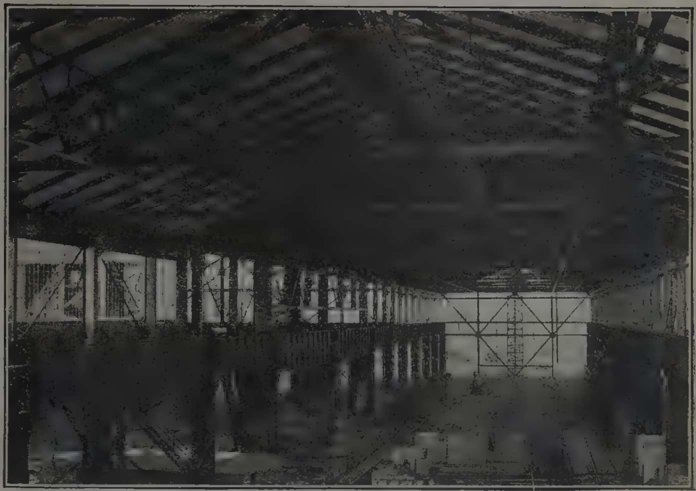


Fig. 8 Forge and Furnace Building, South Aisle, Looking Northeast from Crane Girder, July 12, 1920

Deeper crane girders in left foreground and heavy columns are at 70-ft. spans where cross-tracks will lead to press room on left.

(*g*) The presses and press-drive equipment are concentrated in a central area, thereby avoiding any expensive distribution systems for steam, high-pressure water or electricity.

Furnaces. Twenty-five furnaces are being completed in the

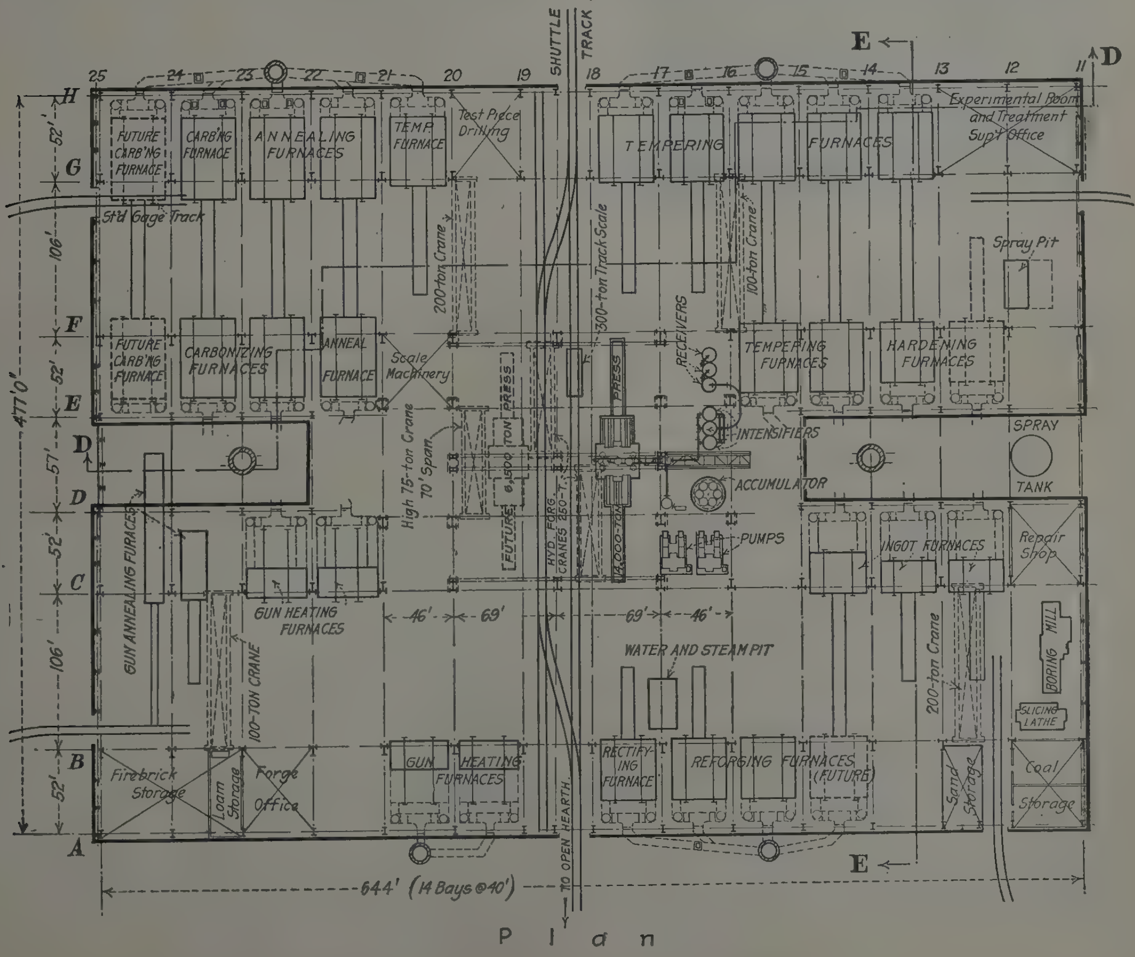


Fig. 7 Floor Plan of Forge and Furnace Building

forge and furnace building. Of these the three ingot furnaces, the two reforging furnaces and the rectifying furnace in the south aisle; the three carbonizing, three annealing, eight tempering and one hardening furnace in the north aisle are identical in section and differ only in length. They are of the regenerative Carbottom type, the fuel is natural gas, and the air preheated. There are three different lengths of furnace, 50, 42 and 36 ft., respectively. The height inside from the floor line to the top of the underside of the arch is 14 ft. 6 in. and the width inside from face to face of the brick work 15 ft. in each case. The general arrangement is shown in Fig. 10.

An interesting feature of the furnace equipment is the car-pulling mechanism. Having in mind the "electric mules" which draw the ships through the locks at Panama, the idea was conceived of using an independent portable electric-driven rack-rail locomotive which would operate on standard-gage tracks placed between the Carbottom tracks and which would draw the Carbottom by means of a standard M.C.B. coupling. A spring reel of cable was arranged for plugging in to the nearest electric power socket and rings were provided for conveniently lifting and carrying the mule to any furnace desired by the overhead crane. The device has subsequently been altered by the operating division to exclude the standard-gage track and wheels, and as built the car-pulling mechanism will be carried on an extension of the girders of the Carbottom furnaces.

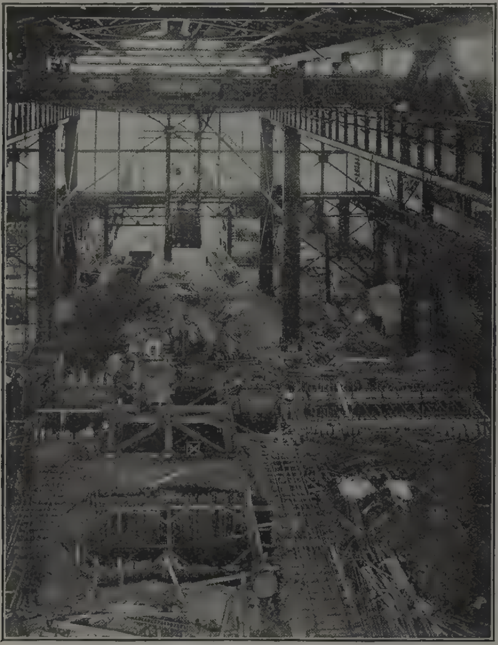


Fig. 9 Press Room, Forge and Furnace Building, Looking East from Crane Girder, July 16, 1920

Foundations for 14,000-ton press in middle foreground. In immediate foreground is excavation for double column which will support inside crane girders running directly across the top of the press. Note high crane for erection and repair of press and forging crane. Note double rails on outside girders for forging cranes. Intensifiers will be located at position of locomotive crane and an 32-in. accumulator where sand pile is shown.

The green-annealing furnaces for gun forgings, one of which will be 100 ft. long, are also of the Carbottom type. The balance of the furnaces are of the solid-bottom type. Six radial-brick chimneys with independent firebrick linings are being erected to serve the furnaces by groups.

Forging Press. The forging press is of 14,000 gross tons capacity and is of the steam-intensified hydraulic type. The maximum working stroke is 90 in. and the four press columns are 19 ft. by 8 ft. 6 in. on centers. The columns are each 30 in. in diameter. There are three cylinders each 44 in. in diameter and the working pressure is 7000 lb. per sq. in. There are two double-acting manipulating jacks in pits on either side of the press, each of 150 tons capacity and having a maximum stroke of approximately 18 ft. Valves are arranged so that one forging cylinder alone may be used, giving greater speed for forging gun work under these conditions. Water is supplied at 2500 lb. pressure by three 250-gal.-per-min. pumps. A 32-in. accumulator operates on this system which also supplies the manipulating cylinders, pull-back plungers and the 250-ton hydraulic forging cranes. The triple intensifier operating on steam at 200 lb. pressure from the boiler plant, increases the pressure in the press cylinders to 7000 lb. per sq. in. The general arrangement is shown in Figs. 9 and 11.

As a matter of general interest, the total weight of the press alone is nearly 5,000,000 lb. The total load at the bottom of the foundation, assuming both cranes loaded directly over the press and including the dead weight of the press and of the concrete foundations is approximately 13,000,000 lb. To support this load it was necessary to place the press on four concrete piers, each 9 ft. in diameter, which bear on rock about 60 ft. below the level of the press-room floor.

Under conditions of eccentric loading there is an extremely remote possibility that a very great side thrust may occur at the top of the press. At the insistence of the manufacturer, a structural-steel brace was designed to take this load, as is shown in the section of the press room (Fig. 11).

All motions of the presses and jack are controlled from a pulpit located on the floor of the press room on line with the press and about 15 ft. away. The hoist motions of the 250-ton hydraulic cranes are also controlled at this point. The bridge and trolley motions of the crane are controlled from cages mounted at the far end of each forging crane whence the operator can most readily line up the piece in the press.

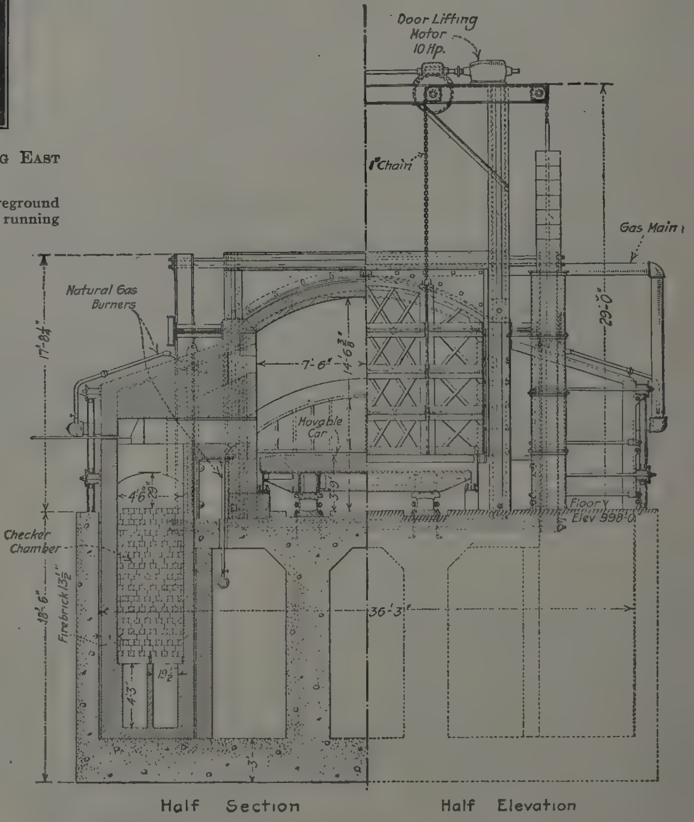
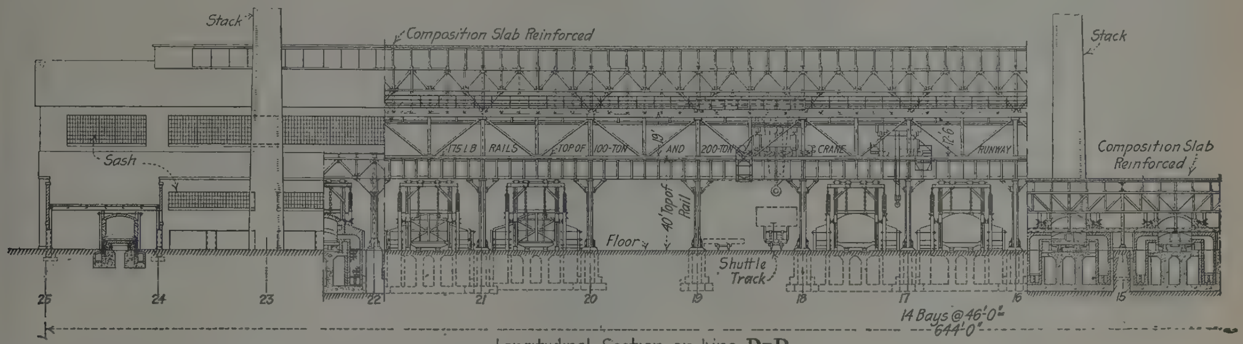
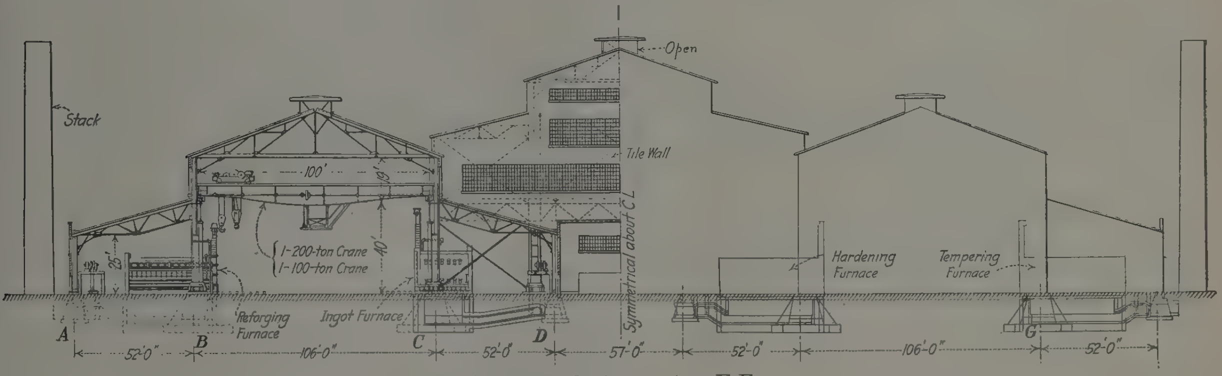


Fig. 10 Section and End View of Carbottom Furnaces for Armor Plate

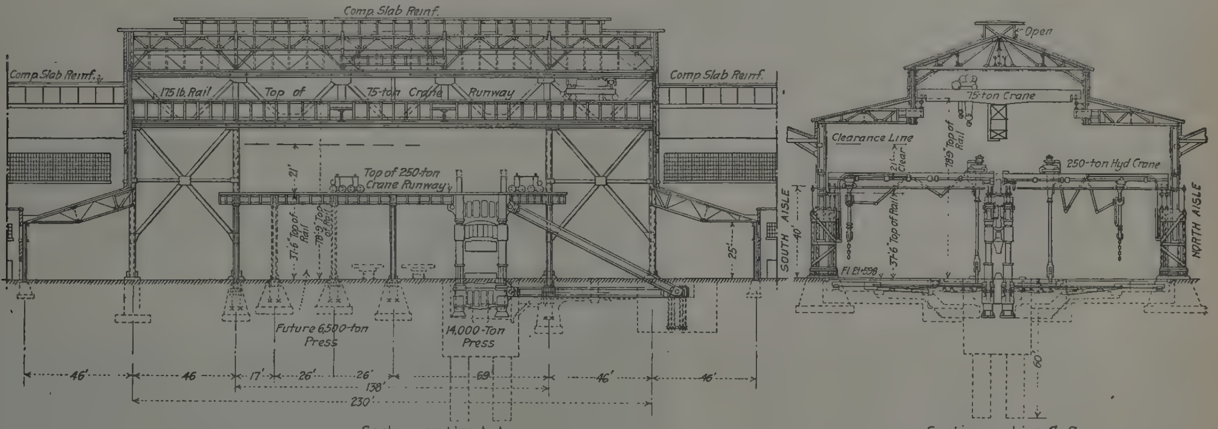
The spray for quenching armor plate is placed at the east end of the north aisle. This consists of a reinforced-concrete pit 16 by 32 ft. by 8 ft. deep. The bottom is covered by a grillage of small pipes perforated with $^1/_4$-in. holes. A carriage on tracks carrying a like grillage straddles the pit. The plate is taken from the Carbottom hardening furnace nearby by a crane and placed on suitable supports in the pit. The carriage is then moved over it and the plate drenched on either or both sides with water. Approximately 25,000 gal. of water per min. are required during the first twenty minutes of the operations. The water from the spray is wasted into the adjacent gully.


Stack
Composition Slab Reinforced
Stack
Sash
175 LB RAILS
TOP OF 100-TON AND 200-TON CRANE RUNWAY
19'
12'6"
40' Top of Rail
Floor
Shuttle Track
Composition Slab Reinforced
25
24
23
22
21
20
19
18
17
16
15
14 Bays @ 46'-0" = 644'-0"

Longitudinal Section on Line D-D



Transverse Section on Line E-E
477'-0"



Section on Line A-A
Longitudinal Section Showing Press and Crane Runways

Section on Line C-C
Cross Section Showing Hydraulic Cranes

Fig. 11 Sections of Forge and Furnace Building

Machine Shop

The general design of the machine shop is shown by Fig. 12. The building is 320 ft. wide by 552 ft. long. It comprises three main aisles, each of which is 100 ft. wide center to center of crane rails. Crane rails are 40 ft. above the floor level.

The south aisle and the middle aisle are to be used for the finishing of the armor plate. Each is served with a 150-ton and a 75-ton crane with 25-ton and 10-ton auxiliary hoists, respectively. The principal machine tools in the south aisle are four planers, two universal borers and drillers of the car type, two universal boring drilling and milling machines, a universal radial drill and two armor-plate grinders. At the west end of the south aisle will be located the burning equipment; gas will be piped from a separate oxy-hydrogen plant which has been built 100 ft. south as a matter of safety. At the west end of the south aisle is the erection floor and the surface plates for the fitting up of armor plate prior to

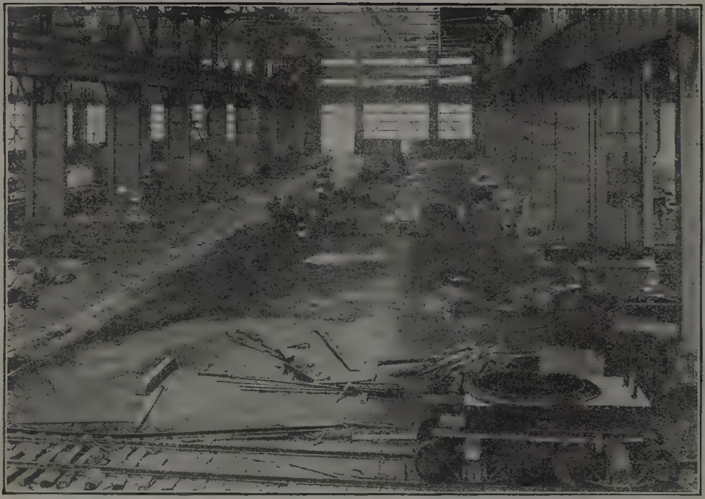


Fig. 12 Machine Shop, Middle Aisle, Looking East, July 20, 1920

Note lighting. Immediate foreground is location of shuttle track. Crane span 100 ft.; girders support one 150-ton and one 75-ton crane. Columns are 46 ft. on centers.

shipment. The erection floor will be 168 ft. long by 93 ft. wide and will consist of a thick reinforced-concrete slab with rails embedded in the surface. The surface plates cover an area 85 ft. by 48 ft. and are of steel. Special arrangements are made in the foundations so that an absolutely level surface may be accurately maintained.

The middle aisle contains an open-side planer, a vertical and horizontal planer, two armor-plate rotary planers and saws, a cutting-off machine and a double armor-plate breast planer. Offices and a tool room will be located in the farthest bay west.

The north aisle which is served by two 75-ton cranes will be devoted to the machining of gun forgings. Equipment of ample size to rough-bore and turn 20-in. 50-caliber gun forgings is provided.

The shuttle track ends in the middle aisle of the machine shop. Gun forgings from the forge shop will arrive by way of the main-track system in order not to make necessary swinging the great length of the forgings through 90 deg., although this can be very conveniently done if required, due to the 100-ft. width of the aisle. Railroad tracks enter both ends of the north and middle aisles and the east end of the south aisle. A track scale of 100 tons capacity is placed on the latter track.

Special attention is invited to the method of securing an abundance of daylight.

Somewhat over 60 per cent of the side and end wall area is in steel sash. Top lighting is provided by longitudinal sawtooth monitors in the side aisles and a double sawtooth monitor in the middle aisle. The construction is shown in Fig. 12.

GUN-TREATMENT BUILDING

This building is located alongside the machine shop, the intervening space 40 ft. wide being roofed over to provide for lockers, toilets, offices and a two-story electric substation for the gun-treatment furnaces. Figs. 13 and 14 show the general arrangement of the building which consists of a low portion and a high portion. A railroad connection from the main-track system runs through the entire length of the building close to the south wall.

The low portion of the building provides space for a future straightening press, storage area for forgings, while awaiting treatment or result of tests, cutting-off saws and slotting and boring machines for the taking of test specimens.

The high portion provides for the vertical treatment of gun forgings. A reinforced-concrete pit approximately 80 ft. square and 55 ft. deep has been built and will contain the 10-ft. by 105-ft. vertical electric heat-treatment furnace and a quenching tank 10 ft. in diameter and 105 ft. high. A 50-ft. furnace is also to be erected on a line with the high furnace and the quenching tank. Space is provided in the pit and on the floor for a duplication of this equipment. Stuctural-steel platforms will be erected around the furnaces in galleries 10 ft. apart, for the convenient inspection of the forging in the furnace during operation through peep holes in the side of the furnace. The steel structure will also support the rolling doors which cover the top of the furnaces and the bridges from which the forgings are hung while in the furnaces. An interesting detail is the installation of an elevator to carry the operator from the bottom of the pit to any one of the ten galleries in the 105 ft. height of the treatment-furnace structure.

The reinforced-concrete pit is of unusually heavy construction in order to withstand the pressure due to its depth, and due to the additional 20-ft. head of water to which the bottom is subjected. The design is unique in that no interior cross-bracing whatever is used. Each of the four sides of the lower half of the pit is designed as a slab supported between the bottom of the pit and a flat horizontal beam at approximately one-half the total depth. The upper half of the walls are designed as retaining walls, for which the flat beam forms the base. Special precautions were taken in the construction of the pit to secure watertightness and the entire concrete work was divided into units each consisting of one full day's pouring of concrete, metal water stops being provided at each construction joint and also where the needle beams of the shoring pass through the wall.

The high portion is served by a 75-ton crane with a 104-ft. span which has a 50-ft.-per-min. hoisting speed at full load, and a 100-ft.-per-min. lowering speed. All motions of this crane are controlled from a pulpit located on line with the quenching tank and at a height just above the top of the furnaces and tanks, on the east wall of the high portion of the building. The furnaces are placed on line with the tank so that only a hoist and a trolley motion will be required in the quenching operation.

The low portion is served with two cranes which are duplicates of the machine-shop 75-ton cranes. The runway of the low por-

Fig. 13 Gun-Treatment Building, Gun Pit in Foreground, July 12, 1920

Note concreting plant to pour 5000 yd. of concrete involved in pit. Sheet piles are 40 ft. long.

tion has been extended into the high portion so that pieces may be picked up and carried directly under the area served by the high crane and thus avoid an additional transfer by rail.

Plant Services

The service features of the plant include the industrial water supply, the sewerage, electrical power and lighting, steam, air, natural gas, etc. The electric, water and compressed-air systems are centered in the service building, which consists of two component parts, an outdoor substation and the service building proper. Electric power will enter the building at 6600 volts, 3 phase, 60 cycles and be distributed from the main buses to all parts of the plant. The building houses four 1500-kw. rotary converters, synchronous condensers, three air compressors, six water pumps, various step-down transformers, necessary auxiliaries and the switchboards for controlling this equipment.

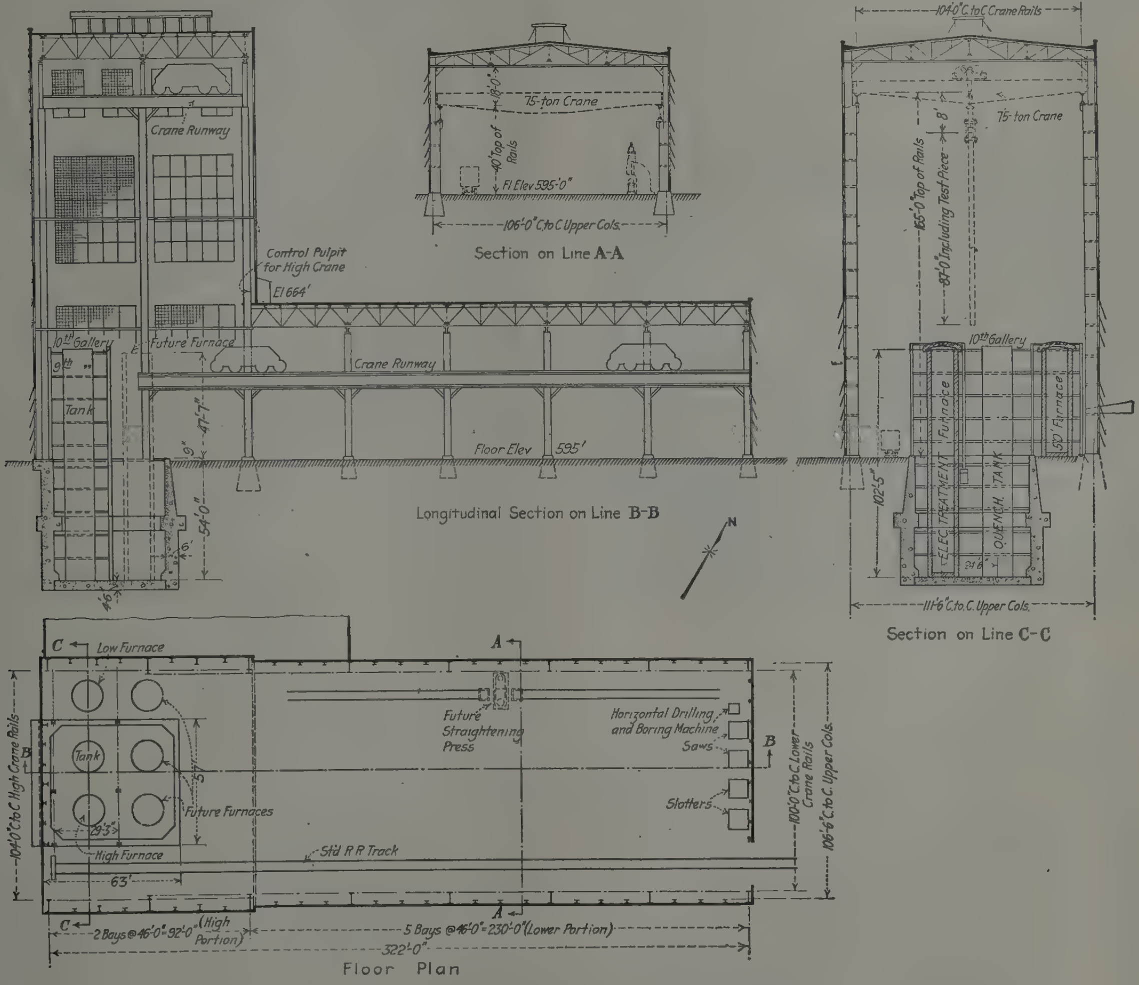

Crane Runway
Control Pulpit for High Crane
El 664'
10th Gallery
9th
Tank
Future Furnace
Crane Runway
47'-7"
9"
Floor Elev 595'
54'-0"
6'
46'
Longitudinal Section on Line B-B
N
75-ton Crane
18'-0"
40' Top of Rails
Fl Elev 595'-0"
A
106'-0" C to C Upper Cols.
Section on Line A-A
104'-0" C. to C. Crane Rails
75-ton Crane
8'
155'-0" Top of Rails
87'-0" Including Test Piece
10th Gallery
Furnace
50' Furnace
102'-5"
ELECT. TREATMENT
QUENCH. TANK
111'-6" C. to C. Upper Cols.
Section on Line C-C
C
Low Furnace
A
Future Straightening Press
Horizontal Drilling and Boring Machine
Saws
B
Slotters
104'-0" C to C High Crane Rails
B
Tank
57'
Future Furnaces
29'3"
High Furnace
63'
Std R R Track
100'-0" C to C Lower Crane Rails
106'-6" C to C Upper Cols.
C
A
2 Bays @ 46'-0" = 92'-0" (High Portion)
5 Bays @ 46'-0" = 230'-0" (Lower Portion)
322'-0"
Floor Plan

Fig. 14 Gun-Treatment Building, Plan and Sections

The outdoor electric substation is for the control of the two 44,000-volt and one 66,000-volt three-phase 60-cycle incoming circuits and consists of 3 banks of transformers and the necessary switches, buses, grounds, and supporting framework.

In general, the electrical distribution system may be outlined as follows: For the distribution of alternating currents, three centers in addition to the main substation and the projectile-plant substation are provided. One of these is located adjacent to the gun-treatment building, in the west end of the lean-to between the heat-treatment building and the machine shop, and controls gun-treatment furnaces, lights, and 220-volt a.c. power in both buildings, and in addition, the d.c. feeders to the gun-treatment building. The second center is adjacent to the press room of the forge and furnace building and controls the hydraulic pumping equipment and the lighting for the building. The third center is under the charging platform near to the electric furnaces in the open-hearth building and controls the electric furnaces and the lighting in that building.

Adequate provisions have been made for secondary distribution systems, distributing centers for direct and alternating current, lighting, etc.

Water Supply. The industrial water supply is taken from the Great Kanawha River which flows west on the north boundary of the reservation. The river pump station is constructed of reinforced concrete directly in the river bank. Two 2000-gal.-per-min. pumps are being installed and space is provided for a third pump. The pump floor is underneath the river level and a positive head thereby assured. Occasional floods bring the river up to 30 ft. or in extreme conditions, 35 ft. The pumps raise the water approximately 50 ft. to a surge tank, whence it flows in a 30-in. tile pipe by gravity to the lower end of the reservoir settling basin. This basin has a capacity of 25,000,000 gal. As the maximum demand of the plant for industrial water is estimated to be approximately 5,000,000 gal. per 24 hr., the reservoir provides at least a five-day settling period for the raw river water.

The water is carried from the reservoir to the service building in a reinforced-concrete flume where the distributing pumps are located in a pump pit which insures a positive head for the pumps.

Distribution is at 60 lb. pressure. As an additional precaution in the remote case that the spray pumps should fail to operate immediately, when the plate was placed in the spray pit for quenching, a standpipe 25 ft. in diameter and 100 ft. high is being provided in the east court of the forge shop.

A separate city water system has been provided to supply water for drinking and lavatory purposes. This water will also be used for 2500-lb. pressure water at the hydraulic press and forging cranes.

Sewerage. Sewerage, waste water and in certain cases, roof water, are gathered from branch systems into the trunk line which, along with the other distribution systems of the plant, including gas, water and electrical conduit, follows the general line of the main west road and the main railroad track across the upper dam and ultimately reaches an outfall several hundred feet below the river pump station. The trunk line is 24 in. in diameter.

Compressed Air. Compressed air is piped at 100 lb. pressure from the service building to the main buildings in a loop system, large quantities being used in the open-hearth, forge shop and machine shop, and also in the blacksmith shop, where air will be used to operate the hammers. A complete loop system is provided.

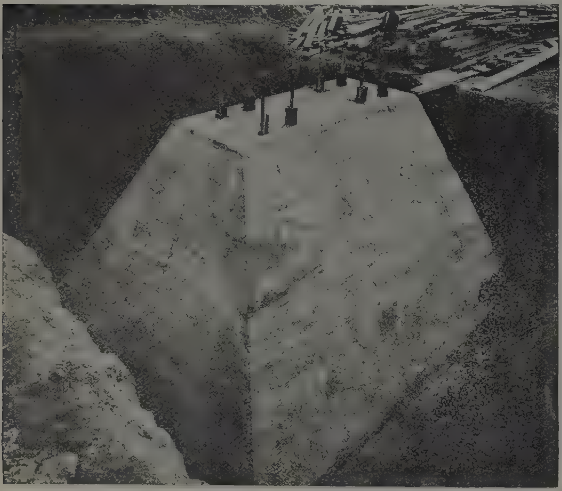


Fig. 15 Typical Column Footing for Row F, Forge and Furnace Building, August 29, 1919

172 cu. yd. concrete. Note man in background.

Natural Gas. Natural gas is obtained from the fields some miles away and will be delivered at the plant at 50 lb. pressure. A loop system is provided with reducer valves located at convenient points throughout the plant. The largest quantities are, of course, used in the open-hearth furnaces and in the furnaces in the forge and furnace building. In the latter building a double loop is provided and meter houses are arranged so that the quantities of gas used in the forge shop and in the treatment shop may be measured separately. The natural-gas supply may be exhausted, it is believed, within the course of the next ten years and with this in view necessary provisions have been made for double checker chambers for the open-hearth furnaces in case producer gas must be resorted to. The use of pulverized coal as a fuel was also in mind when the foundations for the furnaces were designed. Space which was left for double checker chambers can be equally well used for ash baffles.

Boiler Plant. The question of providing the best method of drive for the 14,000-ton hydraulic press and additional capacity to operate a stand-by power plant of generous proportions and take care of the heating of the machine-shop and gun-treatment buildings was gone into very thoroughly and a most interesting method of adapting the reversing rolling-mill drive system to a pressure pump to work momentarily against 7000 lb. per sq. in.

Eight 823-hp. Stirling boilers were obtained from the power plant of the Old Hickory Powder Plant at Nashville, Tenn., and also a separate building of sufficient size to house them. They are arranged four on a side facing each other. The automatic stokers are fed from an overhead concrete bunker of approximately 1000 tons capacity. This in turn is filled by a bucket conveyer from a hopper and crusher located under the railroad siding at the end of the building. The operating floor of the boiler plant is 17 ft. above the ground level so that the grates will be dumped into hopper cars on narrow-gage track and the ash used for fill. Two 12-ft.-diameter by 200-ft.-high radial-brick chimneys have been erected. A 16-in. steam main will run from the boiler plant directly to the press room of the forge shop and an additional line will be run to the service building.

Progress of Construction

Actual work for the construction of the plant began in the latter part of September 1918, when ground was broken for temporary storage sheds. Barracks and mess halls were built to accommodate 1000 men and by January 1919 grading for the classification yard and excavation and foundation work for the open-hearth and machine-shop buildings was in full swing. The first steel work was erected in the open-hearth building on May 30, 1919. Excavation and concreting of the foundations for the forge and furnace buildings were undertaken in July and completed during the month of August, about 8000 cu. yd. of concrete being placed over the extended area in less than six weeks. Fig. 15 shows a typical main row column footing for this building.

During the past year the steel work has been completed on all the buildings except the gun-treatment building. All buildings have been enclosed with walls, sash and roof. Foundations have been completed for the 25 furnaces in the forge shop and for the 14,000-ton press. The 30-ton electric furnaces have been erected. The majority of the cranes have been put into operation. The boiler plant is nearing completion, also the service station. The gun pit and the river pump station are practically done.

The construction work remaining to be completed consists chiefly of the distribution systems for the plant services, the concreting of the roads and the installation of lockers, toilets and offices. Bottoms should be burned in the open-hearth furnaces and the first armor ingots cast by the time this paper is presented. The majority of forge furnaces are now completed and the 14,000-ton press should be erected and in operation by the first of the year.

Progress has been considerably delayed by the difficulty of securing and maintaining a sufficient force of qualified engineers and draftsman, and sufficient labor; the uncertainty of deliveries, due to transportation conditions; and the general unsettled conditions in the material market, although the latter situation was relieved by the obtaining of surplus material and used equipment from the Potomac Park Construction Work in Washington, from Navy construction work at Erie, Pa., and from the Army powder plant at Nitro, W. Va. A large quantity of equipment and material for the entire plant was also obtained from Army salvage.

Organization of Project and Personnel

The United States Naval Ordnance Plant is operated under the direction of the Bureau of Ordnance of the Navy Department. It was designed and built under the joint direction of that Bureau and the Bureau of Yards and Docks. The entire design and construction of the armor and gun-forging plant was done within the Navy and without recourse to a general contractor.

Admiral Ralph Earle was Chief of Bureau of Ordnance until recently relieved by Admiral McVey. The Armor Plant Division of the Bureau has been under the direction of Commander Logan Cresap.

The Chief of Bureau of Yards and Docks has been Admiral C. M. Parks. The Assistant Chief has been Captain R. E. Bakenhus who has also been Project Manager of the Ordnance Plant Division of the Bureau of Yards and Docks as well as Manager of Shipyard Plants for the Emergency Fleet Corporation.

The original Inspector of Ordnance in charge at the Naval Ordnance Plant was Commander J. B. Rhodes. He was relieved about a year ago by Captain George R. Marvel.

The specifications for and purchasing of the 14,000-ton press and its driving equipment and the detailed design of all furnaces and similar equipment were handled by the steel superintendent, Mr. W. J. Priestly, who is head of the Hot Metal Department.

(*Continued on page 726*)

Steam Formulas

A Critical Comparison of the Various Existing Formulations and the Development of a New Set of General Equations

By ROBERT C. H. HECK,[1] NEW BRUNSWICK, N. J.

THIS paper presents the results of an investigation which was at first intended to be no more than a critical comparison of existing formulations, but which soon grew into the task of developing a new set of general equations.

The discussion does not go beyond the four primary quantities temperature, pressure, volume and heat content. The two general or characteristic equations, for superheated steam of course, relate specific volume v and heat h, respectively, to temperature T (absolute) and pressure p (also absolute).

In brief summary, the theory of the subject is as follows:

For a perfect or ideal steam gas the volume equation would be

$$pv = BT \qquad [1]$$

B standing for a constant which is determined by the molecular weight of the substance. According to this formula, product pv would not vary if T were constant, being independent of p as that is varied up or down the isothermal.

With an actual gas, especially near saturation, the product pv shrinks in isothermal compression, after a manner most generally expressed by the equation

$$pv = BT - X \qquad [2]$$

The contractive term X is a function of both pressure and temperature, increasing with p but diminishing as t is higher and as the gas gets farther away from saturation.

From a study of experimental knowledge and as a result of trial against the data, the general term X is given a specific and detailed form which leads to the p-v-T equation

$$pv = BT - \frac{E}{T^m}p - \frac{F}{T^n}p^s \qquad [3]$$

In this formulation the three exponents are fixed as $m = 3.5$, $n = 7.2$ and $s = 2$, while E and F are constant coefficients fixed by trial.

The general formula for heat content is similar to [2], being

$$h = h_0 - X' \qquad [4]$$

for any temperature h has a maximum value at zero pressure and diminishes as pressure rises along the isotherm. An important theoretical relation whose derivation goes back to Clausius ties X' very definitely to X, giving the h-p-T equation the form

$$h = h_0 - \frac{E'}{T^m}p - \frac{F'}{T^n}p^s \qquad [5]$$

The coefficients E' and F' bear to E and F fixed ratios which are rather simple functions of the exponents m, n and s. Zero-pressure heat content h_0 is an empirical function of T.

Three complete sets of equations have been proposed, namely, Callendar's, used by Mollier for steam tables in 1906 and by Callendar himself in 1915; Goodenough's, which underlie the table published in 1915; and the new equations by the writer. Those submitted to the Society by the writer in 1913 used less simple forms for terms X and X' and are not now given serious consideration.

A table in the paper gives all the constants for each of these formulations; and they enter into the comparisons with data, along with other formulations which are listed, notably the Marks and Davis tables.

The theory just described, while rational in its general form, is empirical in the definite valuation of its constants. Unfortunately we have neither method nor knowledge for its synthetic upbuilding from simple elements, so that the only practicable procedure is by trial solutions, testing overall effect against data. A very important determinant, especially for the necessary extrapolation far above the pressure limit of experiment, is furnished by Clapeyron's law. This relates latent heat to the increase of volume during vaporization, by a ratio in which the rate of change of pressure with temperature for saturated steam is the variable factor. The saturation pressure-temperature relation is the most accurately and completely known of the properties of steam, the writer accepting Goodenough's formula for this relation as satisfactory and final. The determinant is applied by evaluating assumed general equations for coincident saturation values of p and t and seeing how closely the resulting ratios agree with those from the independent p-t relation. The writer's final equations are the outcome of between sixty and a hundred trial solutions.

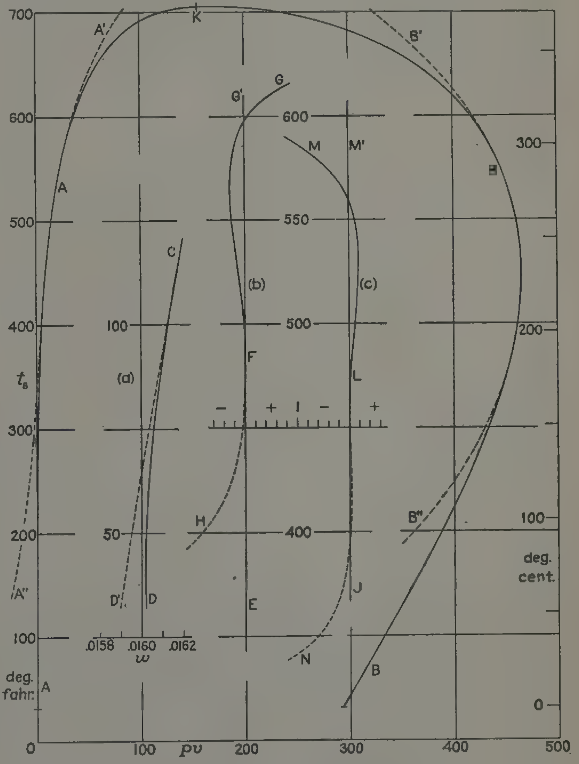


FIG. 1 PRESSURE-VOLUME DIAGRAM FOR SATURATED STEAM

In presenting results and comparisons the paper follows the usual order of the steam tables, considering first saturated steam, then superheated. For the properties of hot water and of dry saturated steam the writer offers new empirical formulas: on the side of saturation these come down from the critical "point" and at about 500 lb. pressure merge with the saturation evaluations of the general equations. Fig. 1 shows a plot of curves for volume, showing product pv rather than the widely variant volume itself. The minor detail diagrams (a), (b) and (c) are concerned with a close study of the merging of formulas, and may be disregarded here. Note that the base (vertical) is saturation temperature t_s. In Fig. 2 the base is changed to pressure and comparisons are made with Marks and Davis (MD) and Goodenough (G) values. Remembering that all experimental data for steam are below 250 lb. pressure or 400 deg. fahr. saturation temperature, it is apparent that extension of the steam tables even to 1000 lb. pressure is very much of an extrapolation, and that theoretical relations which

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[1] Professor of Mechanical Engineering, Rutgers College, Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, December 7 to 10, 1920, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. In this abstract of his paper the author has confined himself to a brief summary of the results of an extended investigation undertaken by him, in which existing steam formulas are compared and a new set of expressions are developed. The complete paper with its abundance of reference data and charts may be obtained gratis upon application by those interested. All papers are subject to revision.

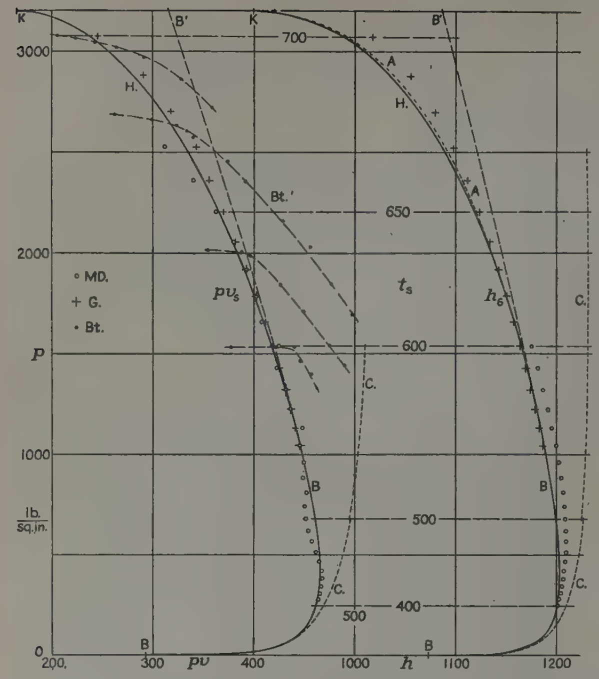

Fig. 2 Diagram of pv_s and h_s on Pressure Base, with High-Range Comparisons

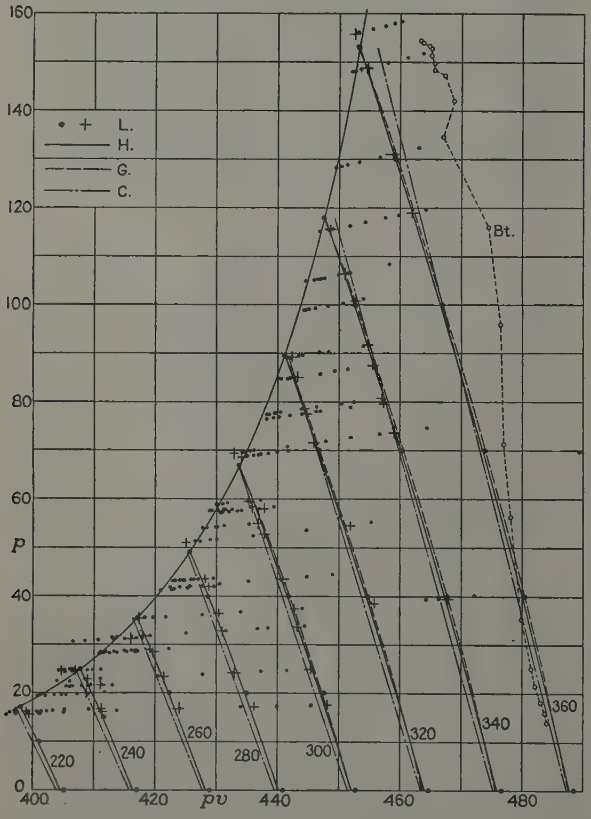

Fig. 3 Comparison of Callendar-Mollier, Goodenough and Heck Isotherms with the Munich Volume Experiments

will guide in making this extension are highly important and useful.

The paper goes on to make close and magnified comparisons of the saturation lines with the low-range data, below 250 lb., to show the exact relative status of all the formulations, from Regnault's down. Turning now, however, to superheated steam, we have the three volume equations compared in Fig. 3 with the Linde data; note how the straight-line isotherms of Callendar (C) fail to conform with the experimental points for the same temperatures, marked +.

Comparisons with specific-heat data are made in Fig. 4, the experiments all having been made at Munich under the direction of Knoblauch and the last lot of them constituting the one body of new data since 1913. There is notably close agreement between the (G) and (H) curves.

A very practical and direct comparison of results on the side of heat content is made in Fig. 4, by plotting isotherms for 400, 500, 600 and 800 deg. fahr., up to 600 lb. pressure. Dotted curves, from the writer's Steam Engine and Turbine are contemporaneous with the Marks and Davis determinations; for high temperatures these are not even reasonably correct, being based on data that have been superseded.

The paper proceeds to discuss the form of the steam equations, describing the action and effect of the Clapeyron relation as a determinant and bringing in use of throttling relations and data as a test of final form. Noting how closely the writer's curves agree with those from Goodenough, the question is raised whether this shall be taken, practically, as an endorsement of the latter. Certain points in Goodenough's solution are rather sharply criticised, one on the ground of doubtful correctness in theory.

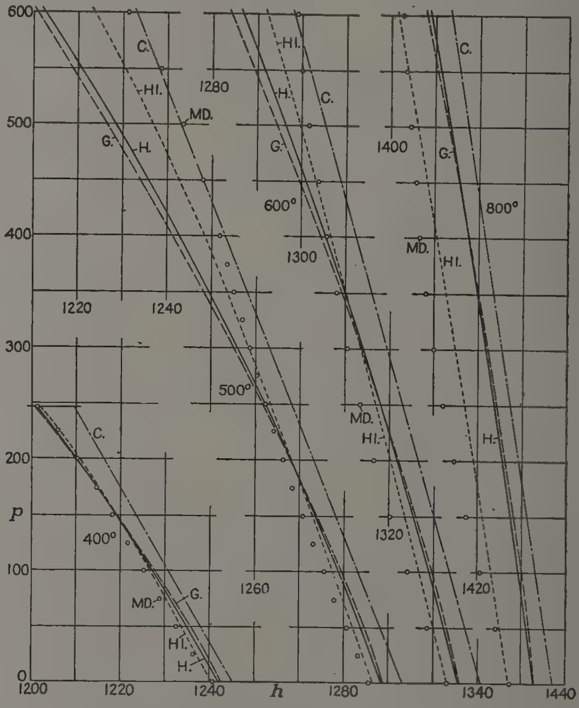

Fig. 4 Comparison of Heat-Content Isotherms

The whole discussion shows how close we are getting to final results in this department of scientific knowledge. The differences between the best solutions lie far within the range of experimental irregularity and uncertainty. The chief need is some accurate data for high-pressure steam, to confirm, or perhaps slightly to modify, the highly probable results now reached in this region. To isolate energy quantities for precise measurement under such pressure conditions would be almost impossible. On the side of volume the physical quantities are much simpler and easier to handle; and under the scheme of related formulas there is diminished need for data in both fields. A comparatively small amount of first-class physical experimentation would be sufficient to resolve any present uncertainty. Pending such information, and with the confident expectation that it can call for but little readjustment, the writer offers his new formulas as the best that can now be done toward establishing a standard steam table.

Foundations for Machinery

By N. W. AKIMOFF,[1] PHILADELPHIA, PA.

The purpose of building foundations is clearly defined and differs radically from that of providing substructures for machinery. Considerable contradiction can be found in blindly applying the principles of the former to the latter, and the results are sometimes so unsatisfactory as to necessitate the use of cushions and other yielding means, thus entirely undermining the very theory on which the foundation was supposedly built. Vibrations arise from either lack of balance or from other causes. The proposed theory contemplates the latter, the problem of balancing being considered as capable of complete solution by suitable treatment. After briefly considering the nature of possible displacements of the foundation as acted upon by various causes leading to vibrations, the author introduces, by way of illustration, a double pendulum, a few experiments with which form the basis of his theory. Means for localizing the expected vibration and of controlling the resulting periods are then illustrated in a working sketch of the proposed arrangement.

THE weight of the Great Pyramid is approximately 5,274,000 tons, its base is 764 ft. square, and its height about 486 ft. It is built on leveled rock. The piers of Brooklyn Bridge are founded 44 ft. below the bed of the river upon a layer of sand, 2 ft. thick which rests upon bedrock. The massive St. Isaac's Cathedral, Petrograd, is built on a swamp, and the piling has been so carefully proportioned that the exceedingly heavy doors of the cathedral swing easily, whereas the slightest lack of uniformity in settling would doubtless lock them. These well-known structures are here mentioned by way of illustrating the obvious purpose of the foundations upon which they rest, i.e., (1) to distribute the load in as nearly uniform a manner as possible; and (2) to secure uniformity in settling.

Just how all this applies to foundations for all sorts of machinery, and in particular to rotative machinery, is not easy to say. Indeed, the weight, say, of a large pumping engine or of a turbogenerator outfit is generally much lower per square foot of floor space occupied than the limits prescribed by municipal laws or building ordinances, and furthermore, uniformity of settling of a relatively small volume of this nature can be secured without going to the extremes usually observed in designing footings for buildings. What, then, would be the general governing idea in proportioning a foundation, say, for an engine of a given type? Should it be heavy or light? Should it be deep, resting on rock or sand if possible? Should it be independent of the footings of the building, or would it be desirable to tie it to the latter?

By examining the existing records we can find a great variety of rather contradictory answers to each question, but the predominant idea in the mind of the designers appears to be somewhat as follows: Since the engine is likely to vibrate, let us tie it as firmly as we can to the earth itself. The mass of the earth being practically infinite, the amplitude of the resulting vibration will probably be zero. The designer may be utterly unconscious of this reasoning, but he applies it nevertheless and obtains results which sometimes are satisfactory and sometimes exceedingly poor.

Causes of Vibration

A rational basis on which to work is thus seen to be lacking and it is accordingly the object of this paper to point out some definite lines along which a rational theory of substructures for engines and moving machinery can in general be built up. To begin with, it is important to realize that vibrations are caused by two distinct orders of agencies: (1) Those due to unbalance, or, more correctly, lack of running balance; and (2) those due to causes other than unbalance.

As regards unbalance, it may be said that this can be so easily corrected in the construction of machinery that all specifications should invariably call for perfect running balance at all speeds, that is, complete absence of tremor or of "periods" under all conditions. However, there are many causes quite independent of balance, each of which is likely to result in vibrations, as for instance, "whipping" of a slender body (crankshaft, armature, turbine rotor, etc.); water in a steam turbine; peculiarities of the reciprocating mechanism—for instance, a 4-cylinder or an 8-cylinder V-type engine where certain forces do not cancel out and where running balance alone is not conducive to perfect results; or torsional vibrations, which under certain conditions produce an effect very similar to that of unbalance. Our problem, then, is to analyze the effect of these various causes, with the view of designing a substructure for a given machine that will be *least responsive* to these causes, for this is what the "relative" freedom from vibrations really means.

But whatever may be the cause of vibrations, it is safe to say that in general they are always due to *forces*, acting in a plane or planes, perpendicular to a certain axis; also to centrifugal *couples*, located in a plane, rotating about a certain line, usually the axis mentioned just above. We know from elementary mechanics that any motion of a body can be resolved into six distinctly separate motions: three *along* the three mutually perpendicular axes drawn through any point, within or without the body, and three *about* these same axes. A free body, capable of a displacement in any of these six modes, is said to possess six degrees of freedom.

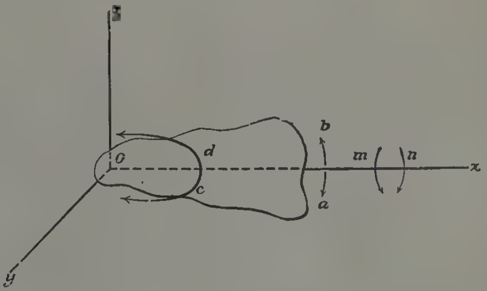

Fig. 1 Diagram of a Body with One Point Fixed

Vibration as Affected by Degrees of Freedom

If the body is rigidly locked so that no displacement of any kind is possible, we say that all six degrees of freedom have been suppressed. By fixing two points in the body we have the effect of rotation about an axis, and only one degree of freedom, that is, the angular displacement about the axis, characterized by these two points. By fixing one point we suppress all bodily motion along any three axes through this point, but we still have three degrees of freedom. Fig. 1 shows a body whose point O is fixed. Such a body can have only three kinds of displacement: (1) about the axis y, as shown by the arrows a or b; (2) about the axis z, as shown by arrows c or d; and (3) about the axis x, as shown by arrows m or n. It makes absolutely no difference what the forces are which act on the body, no other motion is conceivable.

On the other hand, placing a body upon a thick sheet of yielding material, or for that matter on four springs, means freedom in all six directions; and of course the same applies to cushions or pads. For this reason it appears to be of extremely questionable value to interpose layers of such material between a massive subfoundation and the foundation proper of a machine, even if isolated examples are on record where such an arrangement actually *happened* to give satisfactory results.

What is Stability?

With the foregoing in mind, let us digress for a moment. Stability with regard to our subject is a somewhat relative term. Why was the Great Pyramid built upon level rock? To insure stability. Why build a massive foundation for an engine? To secure stability. Why provide a layer of yielding material or springs or rubber pads? To secure stability. In other words, it is

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[1] Mfr. Balancing Machinery, Mem.Am.Soc.M.E.

Abstract of a paper to be presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

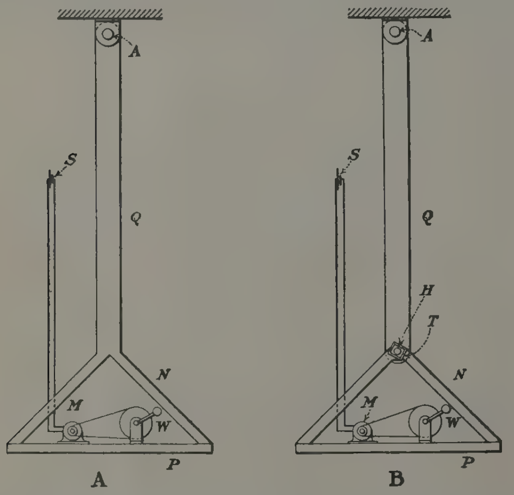
Note: Patent protection controlled by the General Machinery Foundations Co., Philadelphia, Pa.

quite necessary to define in a more rational way the purpose of a foundation for an engine of a given type. We shall attempt to do this, first stating, however, the well-known effects of vibrations on various types of apparatus.

In large power plants where the main units are of the modern turbo-generating type the steam mains have been known to burst, and subsequent investigation has often revealed no defect in either material or in general arrangement of piping. The accident can thus only be explained as due to "rough" running, that is, vibrations.

The operation of a printing plant or of a leather-working factory is often extremely unpleasant for adjoining dwellings, and sometimes even for buildings located at a rather considerable distance. Inspection often reveals that machinery in such plants is firmly secured to extremely massive foundations and the owners are at loss as to how to remedy the trouble.

An internal-combustion engine often exhibits a certain amount of vibration which can be felt all over the understructure. In fact, owing to violent vibrations some of the tie rods, lamp brackets, etc., on automobiles have been known to snap in two, and in aircraft some of the instruments to drop off the board, yet these were parts of the understructure, to which they, as well as the engine itself, were firmly secured. The point we wish to emphasize is that in an understructure too much rigidity is as harmful as too much freedom to yield.



A B

Fig. 2 A—System with One Degree of Freedom; B—System with Two Degrees of Freedom, One of Which May be Suppressed

Stability Defined

We are now ready to formulate the new criterion of stability for foundations. Stability is here characterized by remoteness of the operative speed from any one of the several synchronous speeds at which the frequency of the operative speed would be nearly, or exactly, equal to the frequency of the free oscillation of the system, if displaced from natural state of rest and let go.

How many distinct synchronous speeds a system is capable of having depends upon the number of degrees of freedom. An absolutely free system, for instance, placed upon an elastic subfoundation, may have six independent synchronous speeds, or "critical" speeds, as they are sometimes called. A massive foundation resting upon rock is likewise often apt to be, in the larger sense, free in all six degrees, since it occasionally *does* vibrate and propagate the vibration to other buildings, etc. A system with one fixed point may have only three such synchronous speeds, while a system mounted to rotate about an axis can have only one such speed or "period," as it is often termed. If we could control these synchronous speeds, so as to make sure that none comes anywhere near the actual speed of operation of the machine, we would then have a fairly complete solution of our problem.

Vibration in a Body with One Degree of Freedom

In order to understand clearly the foregoing as well as the broad methods here proposed, let us consider the following experiment and the general consequences manifestly derived therefrom. Imagine a pendulum (Fig. 2-A) consisting of a platform P rigidly connected to the member Q by means of the side members N. The system is free to swing about the axis A in the plane of the figure. A small motor M fastened on the platform operates a countershaft carrying an off-center weight W. The motor is fed through a suitable flexible connection and it is always possible to adjust the speed of the countershaft so that the number of revolutions per minute will be equal to the number of double oscillations per minute of the pendular system. If the latter is slightly displaced from its vertical position of equilibrium and let go, the effect of this adjustment of speed will be the so-called "synchronism," and the extent of swing (amplitude) of the pendular system, in general very slight for arbitrary values of the rotative speed of the weight, will now become violent, in fact, out of all proportion to the magnitude of the weight itself.

This phenomenon of synchronism of cause and effect has been well studied. The amplitude at the exact condition of synchronism should theoretically be infinite, but of course in practice resistances of various kinds are always present, so that instead of *infinite* we have *large* amplitudes. The most curious fact is that in the vicinity of synchronous speed, both above and below, the amplitude drops down to a value almost insignificant, so that if the weight is small the system appears to be practically at rest. Furthermore, any further increase of speed will not produce any effect, contrary to the current opinion of those not very well versed in the matter. For the sake of illustration let this synchronous speed be 100 r.p.m.

Vibration in a Body with Two Degrees of Freedom

As a modification of the experiment let us now provide another system (Fig. 2-B) identical with the first except that the platform P is not solid with the member Q but is pinned thereto at H, the pin used being both frictionless and at the same time so arranged that it can be tightened up by means of the nut T, so as to lock the joint, thereby securing the exact effect of the rigid pendular system of Fig. 2-A. Providing the pin in the language of dynamics is the introduction of an additional degree of freedom, thus securing a system of two degrees of freedom; while the tightening of the nut amounts to suppressing one of the degrees of freedom, thus converting a two-degree into a one-degree system. In experimenting we shall first deal with the system of one degree of freedom, tightening the nut T and thus converting the pendulum into a system exactly similar to that discussed above, the synchronous speed being, say, 100 r.p.m. The pendulum will oscillate violently. We now loosen up the nut T, introducing an additional degree of freedom, with the apparently surprising result that the amplitude decreases practically to zero. If we reduce the speed considerably, say to 50 r.p.m., violent oscillations of the whole system will reappear, as will likewise be the case in speeding up the countershaft, say to 150 r.p.m. These figures are purely illustrative; whether they will actually correspond to exact facts will of course depend upon the characteristics of the system.

In other words, by introducing an additional degree of freedom we have accomplished this double result: (1) What was synchronous speed for a system with a single degree of freedom is no longer synchronous speed for the same system provided with an additional degree of freedom; (2) the new system has two frequencies of oscillation, at which it is sensitive to disturbing influences, one being below and the other above the value corresponding to that of the same system with the additional degree of freedom suppressed.

It should especially be observed that the oscillations were thus reduced practically to zero, not by steadying the system by something without it, but by some sort of an adjustment wholly within the vibrating system itself. Furthermore, what we did was to increase in a measure the flexibility of the system by breaking it in two; and although at first glance this might have increased the effects of the disturbing agency the actual effect was practically

(*Continued on page 699*)

Organization and Construction of Dye Houses

The Machinery Organization, Location, Construction, Ventilation and Piping of Dye Houses Considered from the Engineering Viewpoint

By A. W. BENOIT,[1] BOSTON, MASS.

THERE are two distinct classes of dye houses, one being the converting plant which does dyeing and finishing for the trade; and the other, the plant dye house, which dyes and finishes for one mill only. The first generally covers a wider range and is prepared to do a great variety of work, while the latter is naturally of a narrower scope and is usually limited to dyeing the product of one plant. The converting plant is sometimes equipped to do bleaching and mercerizing, which add complications to their problems. For the purpose of this paper the dye-house problem will be discussed from the standpoint of the plant dye house.

The operation of dyeing enters largely into the four great branches of the textile industry, cotton, worsted, woolen and silk, and in many cases these lap over each other in the individual plants because of the great variety of combinations of stock used in making cloth. Cotton may be dyed in the raw stock, as yarn, or in the piece. Worsteds are dyed in the top, as yarn, or in the piece. The bulk of the woolen fabrics are dyed in the stock but yarn and piece dyeing is also common. Silk is generally dyed as yarn.

Machinery Organization

Following is a list of the kinds of machinery used in cotton, worsted and woolen dye houses. It will be noted that many of the machines appear in more than one of the lists. It must be borne in mind that most dye houses handle more than one kind of stock and in more than one form and will contain machines from more than one group.

Cotton-Dyeing Machinery:
- For Yarn:
  - Boiling-out machines
  - Doubling machines
  - Chain dyeing machines
  - Splitting machines
  - Beam dyeing machines.
- For Piece Goods:
  - Jigs
  - Continuous dyeing machines
  - Padders.
- For Raw Stock:
  - Pressure kettles
  - Rotary raw-stock kettles
  - Hand tubs.
- Miscellaneous Machinery:
  - Dye cans
  - Mangles
  - Washers.

Worsted Dyeing Machinery:
- For Yarn:
  - Rotary skein-dyeing kettles
  - Spool-dyeing kettles.
- For Piece Goods:
  - Piece dye kettles.
- For Slub Dyeing:
  - Top-dyeing machines.

Other Machinery:
- Crabs
- Steamers
- Flat and string washers
- Extractors
- Carbonizing machines
- Dry cans
- Tentering dryers.

Woolen-Dyeing Machinery:
- For Yarn:
  - Rotary skein-dyeing kettles
  - Spool-dyeing kettles
  - Skein dyeing in machines in which liquor is circulated.
- For Piece Goods:
  - Piece dye kettles.
- For Raw Stock:
  - Rotary raw-stock kettles
  - Stock dyeing in machines in which dye liquor is circulated
  - Hand tubs.

Silk-Dyeing Machinery:
- For Yarn:
  - Rotary kettle for skeins
  - Hand tubs.

Location of Dye House

The location of the dye house in the plant is influenced by (1) sequence of operations, (2) water supply, (3) steam supply and (4) drainage. It is impossible to lay down any fixed rule as to the location of the dye house in a plant in its relation to other operations, because most dye houses handle the stock at more than one stage of the process. Each dye house becomes a problem in itself and its location must be decided upon by the particular conditions surrounding it and the purpose for which it is to be used. If a dye house handles its product all in one form such as raw stock, yarn or cloth, its location is easily fixed, and if it handles stock in more than one form there is generally a preponderance of one kind which determines its location. In general, the position of a dye house for various kinds of plants would be as given below, from which it will be seen that the choice of location depends upon the form of the bulk of the product.

Cotton	Dyed yarn	Near warping, dressing and slashing department
Cotton	Piece goods	Near gray room and finishing department
Worsted	Yarn	Near warp-preparing department
Worsted	Piece goods	Near gray room and finishing department
Woolen	Raw stock	Near scouring and picking department
Woolen	Yarn (unusual)	Near dressing room

A dye house requires an abundant supply of clean, soft water. If this is available from a canal or river the dye house can often be advantageously located to secure its supply by gravity and thus avoid pumping. If the water is taken from a pond, it usually has to be pumped and therefore the location of the supply has no influence on the location of the dye house. When the water is so hard as to require a softening plant, pumping is required and the same thing holds true with regard to location.

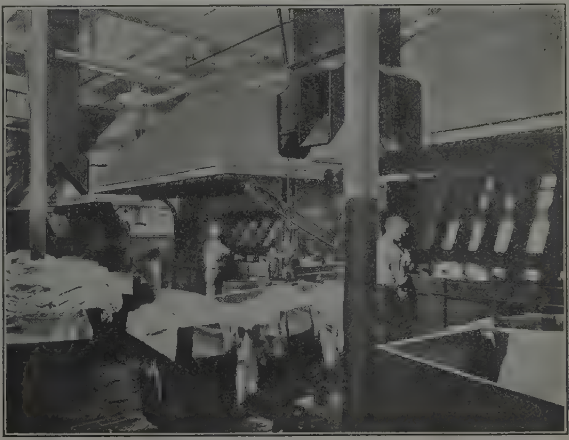


Fig. 1 Dye House with Ventilation

Size of Building. In determining the general dimensions of the building a machinery organization plan must be made of the equipment to be installed. The width of the bay is not essential and is usually about 10 ft. The length of the span from column to column and column to wall should be about 25 ft., providing space for one row of kettles and an ample working alley (Fig. 1).

The kettles should be installed in pairs, right and left hand, with the drives whether belt- or motor-driven, outside, and an alley of 4 or 5 ft. between ends of each pair of kettles. If there are but few kettles they can be economically arranged in two rows in the center of the room, the fronts facing the outer walls with a 12- to 16-ft. working alley. The backs should be set 6 ft. apart. If there are a large number of kettles they are best arranged in four rows. The two outer rows facing the walls with a 12- to 16-ft. working alley, the two inner rows facing the center of the room with a 16- to 20-ft. working alley.

The height of the room should be from 16 to 18 ft. at the eaves. If the building is three spans or more in width there should be a monitor in the middle to light the inner rows of kettles as the window light is largely cut off by the machines and ventilators.

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[1] Assistant Engineer, Charles T. Main.

Abstract of a paper to be presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

Type of Building. A one-story building is the best type for ventilation and light and is the most satisfactory unless crowded for room. Slow-burning mill construction, consisting of brick walls, wood roof and concrete foundation and trenches, is desirable. The use of exposed steel is to be avoided in every way and for this reason wood sash are preferred to steel, because of the corrosion due to moisture and acid fumes. An ordinary flat roof with a monitor, using hard-pine beams and 4-in. spruce plank, works out satisfactorily. The extra thickness of roof plank is necessary in cold climates for insulating purposes. Spruce or Douglas fir is preferable to hard pine as the latter contains resin which is softened by the heat and is likely to drop on goods waiting to be dyed.

All timber and plank used in the roof and monitor should be kyanized after the framing has been done and before putting into place. This necessitates that much of it be done on the job. It is the best safeguard to employ against decay and well worth the expense.

Dyer's Office. An office should be provided for the dyer, located on the north side of the room if possible, having a large window, preferably of plate glass at which he can match samples of work taken from kettles, for shade and color.

Drug Room. Space should be provided for the storage of dye stuffs and chemicals used in the dye house. This room should be near the dyer's office and partitioned off from the kettle room. It should be well lighted and have a steam and water supply to convert dry colors into liquid form before they are placed in the kettles.

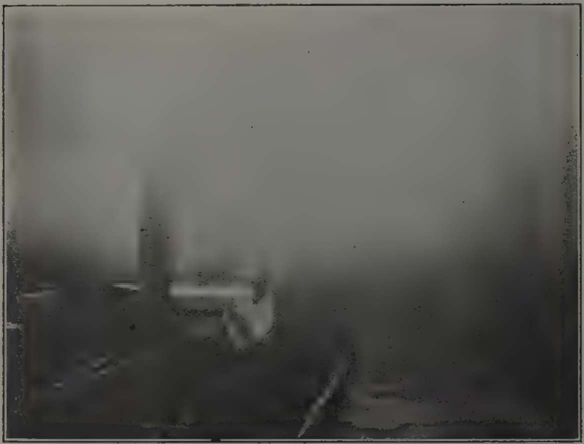


Fig. 2 Dye House without Ventilation

Laboratory. The modern and well-equipped dye house of today is provided with a laboratory where the dye stuffs and chemicals purchased, may be tested and small samples of stock dyed. This should be located next to the dyer's office and connected to it.

Trenches. Practically all types of dye kettles and washers are set so that much of the machine is below the floor level. These should be concrete trenches about 11 ft. wide by 6 ft. deep in which supports are provided for the machines, leaving a clear space underneath for the flow of the waste, and ample room all around to get at all parts requiring attention. In large dye houses and also in those where, because of local ordinances, it is necessary to separate the hot waste dye liquor from the rinse water, an auxiliary drain should be provided in this trench. This is done by installing a separate drain pipe on one side or partitioning off part of the trench. A main intercepting drain crosses the dye house, into which all the trenches are connected, and in some cases two such drains are provided to keep the wastes separate.

Floors. In a dye house of the above description the trenches are planked over after machines are placed and all spaces between the trenches are backfilled and the floor is laid directly on the ground. The floor consists of a concrete base with either a granolithic or paving-brick top, pitched to drain into the trenches. A granolithic top is only good in small dye houses where the trucking is light, because such floors crack more or less and break down at the edges under traffic, causing depressions which hold water and make trucking difficult. A granolithic floor that will stand up under heavy trucking can be laid by placing cast-iron grids on the concrete base and putting the granolithic finish over the grids and floating flush with the top. This floor is expensive but will stand a great deal of abuse. The best floor is obtained by using a vitrified paving brick bedded in cement mortar and well grouted. These bricks should be not less than 2 in. thick and thoroughly vitrified. A common hard-burned brick will not answer the purpose.

The chief cause of obscurity in a dye house when kettles are boiling is not due to steam in suspension but to the dense fog caused by the precipitation of the moisture in the saturated air when it comes in contact with cold ceilings, floors, walls, pipes and cold air seeping into the room. Some of the hot vapor rising from the boiling kettles and tubs will condense on coming in contact with the overhead structure and the water will drip to the floor. That which is not expelled by fans or ventilators will cool off to the room temperature, creating a fog which settles toward the floor, gradually filling the whole room.

The simplest form of ventilation is to depend on the natural ventilation from the windows and monitor. In very small dye houses this gives fair results in summer, but in the cold weather it is inadequate. It can be helped by a large heating system designed to keep the temperature of the air above the point where fog will form, or by putting the dryers in the dye house, but at the best it is unsatisfactory.

It is very often attempted to clear the air by using exhaust fans in the monitor, and while this scheme will remove the hot, oppressive vapors, it does not clear the fog which lies in the lower half of the room. The air necessary to replace that driven out by the fans, comes in at the doors, windows or other inlets, and as soon as the cold air comes in contact with the warmer saturated air a fog is produced which cannot be removed by fans.

Another scheme is to put large wooden hoods over the machines, singly or in pairs, with a vent from each hood going up through the roof and well above it. The idea is to catch the hot vapors before they are dispersed and by means of the natural draft due to the difference in temperature, to get them out of the room. This works out fairly well and will give good results under normal conditions in medium-sized dye houses. There is still some fogging due to the cold air in winter being drawn into the room to replace that carried out with the steam but the humidity is much lower than with open kettles so that this is not so serious.

Some large dye houses have been ventilated without the use of hoods over the machines by means of warm air blown in along the ceiling and delivered in large quantities about 7 ft. from the floor toward the machines. The steam, fog and surplus air escape through the monitor windows or ventilators in the roof. By this method the ceiling is kept dry and the fog is eliminated to a distance of about 6 ft. from the floor. The shafting, piping and equipment in the upper part of the room is obscured by the fog which is moving upward. (Fig. 2).

The system of ventilation which has given the best results is to place over the kettles hoods having vents up through the roof and to distribute warm, dry air over the room and in a blanket on the under side of the ceiling in sufficient quantities to produce a slight pressure. This prevents any cold air from coming into the room and causes the steam to discharge directly up through the vents keeping the ceiling free from appreciable condensation and the room free from visible vapor. The temperature of the air to perform this work should not be over 80 deg. fahr.

The air is furnished by a steel-plate fan taking its air through a sectional heater in which any desired number of sections can be heated depending on the temperature, and distributed about the room by a system of air ducts suspended close to the roof, having outlets delivering a blanket of warm air along the ceiling, eliminating all condensation from that source and having branch ducts dropping down to within 7 ft. of the floor with outlets discharging toward the hoods and about the room. During the summer months the windows should be kept closed and the apparatus kept in operation but without steam on the heater. With the room clear of all condensation, vapor or steam, individual or group motor drive for the dye-house machinery may be used with safety.

(*Continued on page 706*)

Rational Design of Hoisting Drums

By EVERETT O. WATERS,[1] NEW HAVEN, CONN.

The main problem of hoisting-drum design resolves itself into two parts: determination of flange shape and thickness, and determination of the thickness of the drum body. Other factors, such as brake, clutch, and bearings, have already been investigated and are therefore not considered in this paper.

Flange thickness is a function of (a) rope tension and (b) depth of winding. Previous theoretical investigations have recognized these factors but have failed to take account of the friction between adjacent coils of rope and between rope and drum, which tends to hold the coils in position without the aid of the flanges, and have also disregarded the flattening of the inside coils under pressure from the outer layers.

A theoretical formula is deduced for the total pressure against a drum flange caused by the winding-on of rope to a given depth and under a given initial tension. Two other formulae are then deduced, which relate this total pressure to the flange thickness and the maximum allowable tensile and shearing stresses in the material. By means of these formulae a flange of the usual straight-sided or the mushroom type may be designed to withstand safely the pressure of the rope wound upon the drum.

The drum body is subjected to combined stresses, since it is under compression from the coils wound upon it, under tension due to the lateral pressure against the flanges, and under combined torsion and bending caused by the load which is to be hoisted. Formulae are derived which may be used to obtain the correct thickness both at the center of the drum, where the normal stresses are greatest, and at the ends of the drum, where the shearing stresses are most prominent.

Tests were made with small-size rope wound upon a special drum, which was so arranged that the side thrust against one flange could be directly measured while the rope was being wound on or unwound. These tests show conclusively that formulae for flange pressure which do not take account of rope friction and flattening give excessively large results.

SOMEWHAT over a year ago the writer's attention was called to certain details in the design of rope-winding drums as commonly used in hoisting and conveying machinery. Upon investigation it appeared that little if any study of this subject had been made beyond the private researches of various firms engaged in manufacturing hoisting apparatus. Published matter dealing with this class of machinery makes scanty reference to the design of hoisting drums, and recommends proportions based on careful guesswork or previously accepted practice rather than upon theory or experiment.

Such being the case, it seemed well worth while to make a special study of the hoisting drum, with a view to deducing some logical rules for proportioning the important parts. There are in reality only two such parts that require this analysis: the drum body or core, and the flanges. Other details, such as length of bearing, size of arms connecting the drum core with the hub at either end, and proportions of brake and clutch surfaces, present no novel problems; a discussion of these parts is accordingly omitted from this paper.

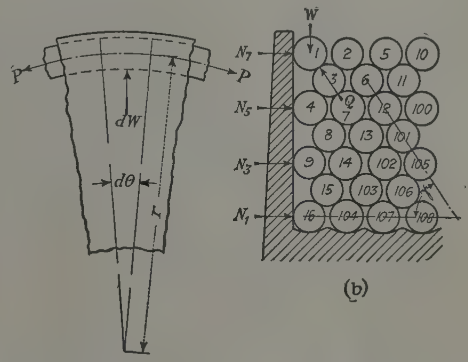
DESIGN OF DRUM FLANGES

In many installations of hoisting machinery the length of rope to be handled is not great and it is quite possible to wind it in a single layer on a drum of moderate diameter and length. This is, of course, the most desirable arrangement, since it insures uniform hoisting speed, obviates the danger of overwinding at either end of the drum if the rope is improperly guided, and prevents the wear on the individual wires which results when two or more coils are wound on the drum in contact with each other. However, it is often necessary to wind great lengths of rope on comparatively small drums, and in such cases the end flanges must be relied upon to support the rope at the ends of the layers of which there may be as many as 14, 16 or more. In addition these flanges are usually subjected to a stress from brake, friction clutch, or both. It is therefore necessary to know (*a*) the maximum tangential load on the flanges caused by the brake, (*b*) the maximum axial or tangential load due to the clutch, and (*c*) the load due to the axial thrust of the several layers of rope.

THEORETICAL DETERMINATION OF AXIAL THRUST

First Method. The first two of these loads can be found quite readily, as explained in treatises on brakes and clutches. The third is much more difficult to determine, and it has been suspected for some time that the theoretically obtained values for this thrust or pressure do not agree with the facts. The series of tests described in a later paragraph were made for the express purpose of throwing light on this point.

In deriving a simple formula for the axial thrust, it is assumed that the coils of rope are wound uniformly, the coils of each successive layer resting in the spaces between coils of the preceding layer, as shown in Fig. 1. Friction between contiguous coils and between rope and drum surface is neglected. If the drum is grooved, as shown in the figure, all coils in the central part of the drum (those numbered 100 and higher in the figure) will be self supporting, while a certain number of coils, occupying a space of wedge-shaped cross-section at each end of the drum, must rely upon the flanges for their support. Thus in Fig. 1 the coils numbered 1 to 16, inclusive, are the only ones which will cause axial thrust against the left flange. This thrust, which is indicated by the forces N_1, N_3, N_5, etc., in Fig. 1, is computed as follows:



(b)

(a)

FIG. 1 DIAGRAM OF COILS WOUND ON GROOVED DRUM

When there are $2m - 1$ layers of rope,

$$N_{2m-b} = bW \cot \gamma = 2\pi bP \cot \gamma \ldots\ldots\ldots\ldots [1a]$$

$$N_1 = (m-1)W \cot \gamma = 2(m-1)\pi P \cot \gamma \ldots\ldots [1b]$$

When there are $2m$ layers of rope,

$$N_{2m-b} = (b+1)W \cot \pi = 2(b+1)\pi P \cot \gamma \ldots\ldots [1c]$$

$$N_1 = (m - {}^1/_2)W \cot \gamma = (2m-1)\pi P \cot \gamma \ldots\ldots [1d]$$

The total axial thrust for an odd or even number m of layers is approximately

$$N_1 + N_3 + N_5 + \ldots + N_m = N = \frac{m^2 - 1.5}{2} \pi P \cot \gamma \ldots [2]$$

Second Method. The foregoing expressions are easy to use, but in the writer's opinion give results which are excessive, this being corroborated by the experiments described toward the end of the paper. Three important factors have been disregarded: friction; cross-over of the rope from a given space between coils on the preceding layer to the second space beyond, due to the fact that alternate layers are wound right and left hand; and compression of the internal layers. All three of these tend to lessen the axial thrust. An approximate expression for this thrust, as modi-

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fied by these conditions, may be found by considering the end coils as a solid wedge *abcd*, Fig. 2, upon which forces are acting as indicated. The effective slope of this wedge is not the actual slope γ of the center lines of the coils, but is $90° - \gamma$, because that is the actual inclination of the contact surfaces between contiguous coils. The coefficient of friction γ is probably higher for rope on rope than for rope on drum. For example, some experiments performed by the writer gave 0.201 for the friction of rope on rope and 0.181 for rope on drum, these results having been obtained by wrapping a short length of $^1/_4$-in. rope around a drum, hanging a known weight from one end of the rope, and then suspending enough weight from the other end to just cause slipping. The rope was bright, but not lubricated, except with the grease applied in manufacture; the drum was finish-turned and unlubricated. In view of the closeness of these results, a single value for μ has been assumed in the following analysis.

The radial force R_1 is indeterminate; it is therefore assumed equal to $1/p$ times the vertical component of all forces acting along *dc* and *cb*, where p is the number of coils between *a* and *b*. For example, if there are six layers as in Fig. 2,

$$R_1 = \frac{1}{3^1/_2}\left[R_1 + Q\,(\sin\gamma + \mu\cos\gamma)\right]$$

$\Sigma(W)$ is the sum of the radial components of the tensions on all the coils in the wedge; in other words, $\Sigma(W) = 2\pi\Sigma(P - P')$, where P is the initial tension in each coil and P' the tension loss in the same coil due to the pressure from outer layers.

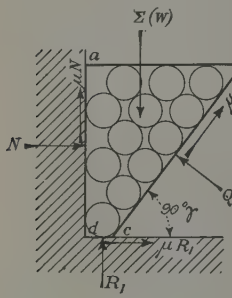

FIG. 2 (LEFT) DIAGRAM SHOWING FORCES ACTING IN ROPE WOUND ON DRUM

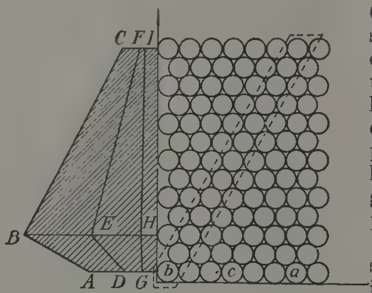

FIG. 3 (RIGHT) DIAGRAM SHOWING DISTRIBUTION OF AXIAL THRUST OVER SURFACE OF FLANGE

Taking the sum of the horizontal and vertical components of all the forces shown in Fig. 2 and eliminating R_1 and Q, the following equation for the end thrust against each flange is obtained:

$$N = \frac{(p - \mu^2 - 1)\cos\gamma - \mu p \sin\gamma}{(1 - \mu^2)\,p\sin\gamma + \mu(2p - \mu^2 - 1)\cos\gamma}\,2\pi\Sigma(P - P') \quad [3]$$

This equation is to be considered as a refinement of Formula [2], in which no account was taken of μ or P'. It is interesting to note what widely divergent results the two formulæ give, especially when the number of layers is large.

The tension loss P', which to the best of the writer's knowledge has hitherto been disregarded or avoided in all published works dealing with the design of hoisting drums, deserves some discussion at this point. As each successive layer is wound on the drum, the preceding layers are flattened out to a certain extent; this reduces the actual length of each flattened coil and thus relieves it of a part of the initial tension P which was applied by the hoisted load at the moment when the coil was wound upon the drum. Suppose, for example, that a $^1/_4$-in. rope is being wound upon a 10-in. drum under a tension of 1000 lb. First, the bottom layer is completed, each coil having the initial tension of 1000 lb. Then the second layer is wound on, each coil of which has a tension of 1000 lb. But at the same time, the tension in each coil of the first layer drops to 700 lb. When three layers have been completed the outside layer is under the initial tension, while the tension in the second layer has fallen to 500 lb. and that in the first layer has dropped from 700 to 600 lb. With four layers the effect is still more pronounced, the respective tensions being 1000, 400, 250 and 500 lb. In general, the maximum compression occurs near the middle layer; the inner layers are prevented from much shortening by the unyielding surface of the drum, while the outer layers, being near the surface, are acted upon by comparatively small radial forces.

It is possible to determine the reduction in tension in each layer, and hence the value of $\Sigma(P - P')$, by a simple analysis of the mechanical principles involved. Unfortunately, however, as the number of layers of rope increases the number of unknown quantities increases correspondingly, and the equations which accumulate can only be solved after much laborious computation. But by making the assumption that the radii of all the layers are approximately equal, the formulæ are greatly simplified. Table 1, based on this assumption, gives values of P' for each layer, in terms of the initial tension P, for windings of a number of layers.

The quantities E' and m, involved in the expression for h in Table 1, deserve a word of explanation, since they represent properties of the rope which determine the extent to which it will yield under lateral pressure. E' may be termed the "lateral modulus of elasticity," and defined as the ratio of lateral pressure per unit length of rope to the decrease in rope diameter measured along the line of action of the pressure. On account of the non-homogeneous character of wire rope, E' bears no direct relation to the true modulus of elasticity E and is best determined by test. The writer obtained the value $E' = 9260$ lb. per sq. in. for new $^1/_4$-in. 6 by 19 hoisting rope with hemp center. Obviously rope with steel center would give higher values of E', while cotton-centered or 8-strand rope would probably give lower values, on account of the greater softness of the core. The coefficient m is a factor of lateral deformation, or ratio of the increase in rope diameter along one axis to the decrease along a perpendicular axis, the lateral pressure causing this deformation being assumed to act along the latter axis. Its value is probably less than 0.3, the value for homogeneous steel, since the pressure which causes deformation is applied at isolated points instead of over the entire surface.

An example was worked out using both formulæ. With the same values in both cases the aggregate tension on all the coils in the wedge, taking the flattening of the coils into account, was found to be 34,460 lb. as compared to an aggregate tension of 63,000 lb. neglecting this flattening effect.

Formula [3] tells nothing about the distribution of the axial thrust over the surface of the flanges. According to the first method for determining it, where friction and coil flattening are disregarded, the distribution over a small sector is as indicated by the line *ABC*, Fig. 3. The effect of friction is probably to reduce the abscissæ of the shaded area a constant amount, to such a line as *DEF*. But the aggregate effect of coil flattening is much more pronounced near the drum body, so that when both friction and coil flattening are considered, the pressure is in all likelihood distributed with a fair degree of uniformity over the sector of flange. This is indicated by the line *GHI*. The experiments described later point toward the same conclusion; and in the absence of more definite information, a uniform distribution of load over a given sector will be assumed in determining the strength of the drum flange.[1]

EFFECT OF UNGROOVED DRUMS ON AXIAL ROPE PRESSURE

Thus far it has been assumed that the surface of the drum body is grooved. This is undoubtedly the best practice, since it insures the proper spacing of coils, tends to make the winding of all the layers uniform, and reduces wear. In addition it makes the coils of rope in the middle of the drum self-supporting, without the aid of the drum flanges.

With the ungrooved drum, the tendency of the bottom coils to side-slip is counteracted partly by friction, and partly by the fact that a number of coils in the middle part of the drum are "balanced," that is, the pressure from the outer layers which tends to slide one of these coils to the left, is counteracted by an equal and opposite pressure tending to slide the coil to the right. In Fig. 3 the coil *a* is thus balanced; but all the bottom coils to the left of *a* receive an excess of pressure from the right, which tends to slide them to the left. This means (remembering that all coils in a layer are in contact with each other) that an additional load in the nature of a shearing force is placed upon the drum flange.

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[1] By "uniform distribution over a sector" is meant a distribution in which (load per unit area) multiplied by (distance from area to drum axis) is constant. This should not be confused with the common meaning of uniform distribution, as used in connection with beams, floors, etc.

Coil b, Fig. 3, presses against the flange with a force $(m - 1) \times \pi P \cot \gamma$, neglecting friction, compression of coils, and the pressure of the coil immediately to the right. This force is caused by the coils included in the oblique strip indicated by dotted lines. Denoting by $\Sigma(P')$ the total tension loss in these coils due to compression, and taking account of the friction between coil b and the drum body and flange, the net pressure of this coil against the flange is

$$N_1 = \pi[(m - 1)P - \Sigma(P')] \frac{\cot \gamma - \mu}{1 - \mu^2}$$

The coils between b and a will cause a pressure against the flange, of similar form but smaller magnitude, the decrease being due to the partial balance of these coils. Therefore it may be assumed that the total shearing force on a drum flange caused by nongrooving of the body is

$$\Sigma(N_1) = \frac{\pi n}{2} [(m - 1)P - \Sigma(P')] \frac{\cot \gamma - \mu}{1 - \mu^2} \ldots\ldots [4]$$

n being the number of unbalanced coils in the first layer.

The problem of deducing a relation between load and stress in the flange is no easy one to solve, owing to the diverse forms of flanges which are embodied in standard designs, and the use of stiffening ribs, wide rims, etc. After considerable study the writer selected the mushroom type illustrated in Fig. 4 as being the simplest and at the same time the most widely used. The load-stress-flange-thickness formulæ were then derived by first obtaining a relation between the radial and tangential strains at any point in the flange and the coördinates of that point. This gives a relation between the true radial, tangential, and shearing stresses at the point and the coördinates of the point. By a single integration the total shearing stress on a cylindrical section of the flange containing the point was found; this was set equal to the external load acting on that part of the flange between the cylindrical section and the rim; and after successive integrations the deflection of the point was obtained. By proper substitution the true radial, tangential and shearing stresses at the point could then be found in terms of known quantities, i.e., the flange thickness, inside and outside radii, and external load. By giving this general point certain specific locations, a number of formulæ were deduced.

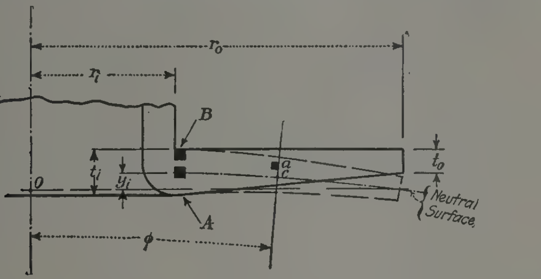

Fig. 4 Diagram for Study of Stresses in Flange of Hoisting Drum

In determining the constants of integration the following boundary conditions were assumed: The shear at the surface of the flange is zero; the radial stress at the rim of the flange is zero; the slope of the deflected flange is zero at the shoulder (rigid connection between flange and drum body); and the deflection of the flange at the rim is a maximum. In order to simplify the integrations, the following relation was assumed between the thickness of the flange and its radius:

$$t_r = \frac{1}{\sqrt[3]{\alpha + \beta r}}$$

where t_r = thickness of flange at radius r, and α and β are constants. This gives a shape of flange closely approximating that in Fig. 4. A special case arises when $\beta = 0$; the flange is then of constant thickness.

Formulæ were derived for the radial stress (tension and compression) at shoulder of flange, p_r; tangential stress (tension and compression) at rim of flange, p_t; and for shearing stress at the shoulder of the flange, s. These equations give the stresses caused by the lateral rope pressure. By a similar analysis it is found that the action of the clutch causes similar stresses at the clutch flange, namely, p'_r, p'_t and s'.

These latter stresses act counter to the stresses p_r, p_t and s. In other words, when the first layer of rope is being wound on the drum, the clutch flange is stressed in tension in the region A, Fig. 4; but as the number of layers increases, this stress becomes less and less until a point is reached at which p_r and p'_r exactly neutralize each other, after which p_r becomes the greater and the flange is under tension in the region B. As a rule the net stress due to loads N and C combined will not exceed p_r, p_t and s, unless the depth of winding is kept down to two or three layers.

To determine the effect of the turning force S, consider (1) a small cube in the region B, Fig. 4, and (2) a small cube halfway between A and B, on the neutral surface. The first cube is subjected to an apparent radial stress $p_1 = (p_r - p'_r)q^2/(q^2 - 1)$, an apparent tangential stress $p_2 = p_1/q$ and a shear $S/(2\pi r_i t_i)$. Combining these in the usual manner to find the principal stresses, and combining the principal stresses to find the true stresses, we have:

$$p' = \frac{1}{2}\left[(p_r - p'_r)^2 + \sqrt{(p_r - p'_r)^2 + \frac{S^2(q + 1)^2}{\pi^2 r_i^2 t_i^2 q^2}}\right] \ldots\ldots [5]$$

$$S' = \frac{1}{2}\sqrt{(p_r - p'_r)^2 \frac{q^2}{(q + 1)^2} + \frac{S^2}{\pi^2 r_i^2 t_i^2}} \ldots\ldots\ldots\ldots [6]$$

q being the factor of the lateral contraction. The second cube is subjected to no normal stresses, but to two shearing stresses at right angles to each other, $S/(2\pi r_i t_i)$ and $0.23qNt_i^2/(r_o t_o^3)$. Hence the total stress is the algebraic sum of these two.

The writer must admit that these formulæ have a formidable appearance and will be likely to discourage the designer who is looking for simple and easily applied rules. The chief difficulty lies with equations for p_r, p_t, p'_r and p'_t; when these have been solved it is a comparatively simple matter to apply Formulæ [5] and [6] as checks to determine whether the addition of a force S will still keep the stresses within safe limits. On the other hand, the equations for p_r and p_t may themselves be much simplified by omitting terms of negligible value and by assuming that the flange is of constant thickness. When the winding space is shallow as compared with the diameter of the drum, the flanges approximate short cantilever beams of depth t_i, width $2\pi r_i$ and carrying a uniformly distributed load N and a concentrated load $-C$. The tangential stress vanishes, the maximum radial stress becomes

$$p_r = 0.477(1 - k)\frac{N - 2C}{t_i^2} \ldots\ldots\ldots\ldots [7]$$

and the maximum shear (due to loads N and C) becomes

$$S = \frac{0.23q(N - C)}{r_i t_i} \ldots\ldots\ldots\ldots [8]$$

The additional stress caused by load S may be found as in Formulæ [5] and [6].

Determination of Stresses in the Drum Body

The obvious load in this case is one of compression, due to the crushing effect of the rope wound upon the drum under tension. There are, however, additional applied forces which should be considered in a careful analysis of the problem. Besides acting as a cylinder under external pressure, the drum body is also a beam supported at the ends and carrying a moving load, a shaft transmitting a torsional moment and a tensional member serving to tie the flanges together. These forces combine to produce definite stresses which vary in different parts of the drum, so that it is necessary to select certain points at which the stresses are to be determined and to assume certain positions for the moving load P. The most suitable points are shown in Fig. 5 by two unit cubes, set "square" with the drum, it being assumed that the rope pull is acting vertically upward. One of these cubes is in the center of the drum body, on the side which is under tension, considering the drum as a beam; the other is alongside one of the points of support of the drum body and in the neutral plane.

Consider the first cube. On each face there is a normal force and in the x-y plane there is a shear due to the torque transmitted. X is a tension caused by the rope pressure on the flanges, minus the clutch presure, to which is added the tension caused by the bending effect of the load which is assumed to hang from the middle of the drum. Dividing by the section area for the direct tension, and using the common flexure formula for the bending, we have, approximately,

$$X = \frac{N - C}{2\pi r_i t_d} + \frac{Pl}{4\pi r_i^2 t_d}$$

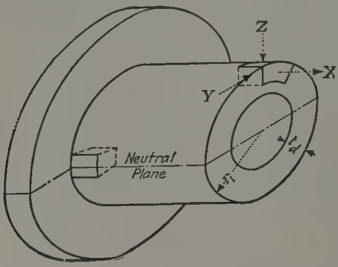

Fig. 5 Diagram for Study of Stresses in Hoisting-Drum Body

where l is the length of the drum between bearing centers. Y is a pressure due to the rope tension; on the basis of a uniform distribution of this load over the entire drum body,

$$Y = -\frac{mP - \Sigma(P')}{vt_d},$$

v being the pitch or spacing of coils.

$$Z = \frac{Yt_d}{r_i} = -\frac{mP - \Sigma(P')}{vr_i}$$

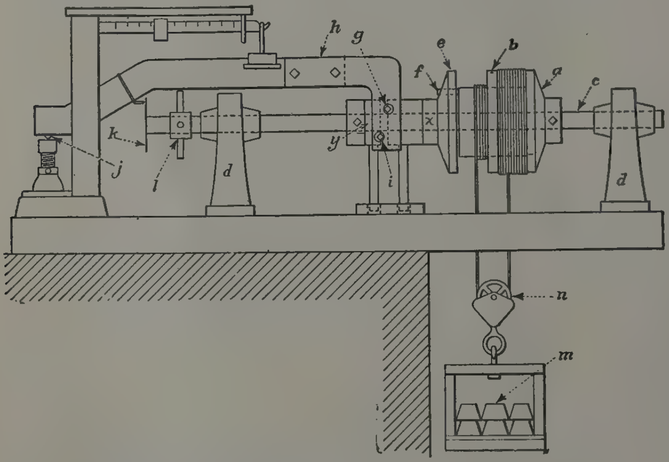

Fig. 6 Diagram of Apparatus for Determining Axial Thrust on Flange of Hoisting Drum

The shear due to the twisting moment is a maximum when the rated load P is acting on the outermost layer that can be wound on the drum. Denoting the radius to the center of this layer by r_m, and substituting in the usual torsion formula, the shear is equal to, approximately,

$$W = \frac{Pr_m}{2\pi r_i^2 t_d}$$

The X and Y stresses can be combined with the shear W, giving the principal normal stresses and the maximum shearing stress

$$\frac{1}{2}\sqrt{(X - Y)^2 + 4W^2} \ldots\ldots\ldots\ldots\ldots [9]$$

From these are derived the true normal stresses

$$X' = \frac{q - 1}{q} \times \frac{X + Y}{2} + \frac{q + 1}{q} \times \frac{\sqrt{(X - Y)^2 + 4W^2}}{2} - \frac{Z}{q} \quad [10]$$

$$Y' = \frac{q - 1}{q} \times \frac{X + Y}{2} - \frac{q + 1}{q} \times \frac{\sqrt{(X - Y)^2 + 4W^2}}{2} - \frac{Z}{q} \quad [11]$$

$$Z' = Z - \frac{X}{q} - \frac{Y}{q} \ldots\ldots\ldots\ldots\ldots [12]$$

To solve for t_d it is only necessary to make the proper substitutions in the equations for X, Y and Z, then to substitute these in Formulæ [9], [10], [11] and [12], solve, and take the result which is numerically largest as the correct value for the thickness. When the allowable tensile and compressive stresses are different, as in the case of cast iron, it may be assumed that X' represents a tensile, and Y' a compressive, stress. The sign of Z' depends largely upon the relative values of X and Y, and in general Z' will be small if based upon a value of t_d obtained by solving Formulæ [10] or [11].

Consider now the second cube, located in the neutral plane of the drum body. The stresses Y and Z are the same as before; but X reduces to

$$X = \frac{N - C}{2\pi r_i t_d}$$

since the bending moment at this point is zero; and W becomes

$$W = \frac{Pr_m}{2\pi r_i^2 t_d} + \frac{P}{2\pi r_i t_d}$$

where the first term represents the shear due to torsion, as before, and the second term the maximum shear due to bending. By making the same substitutions as in the previous case, the correct value of t_d may be found for the drum body at either end.

Experimental Investigation of Axial Thrust

The apparatus used for this work is shown in Fig. 6, a being the drum, which is fastened rigidly to the shaft c supported in bearings d, d. An adjustable flange b divides the drum into two parts. The left end of the drum is without a flange, but close to it is placed the separate flange e, which has an easy sliding fit on the shaft but is made to turn with it by means of the pin f. Any axial load against this loose flange is transmitted through the knife edge g to the lever h, fulcrumed at i and bearing upon platform scales at j; thus by balancing the scales a quantitative indication of this side thrust can be obtained for any number of turns of rope upon the drum. The number of turns is shown by the dial k, and can be varied by turning the shaft by means of the capstan l. The platform and weights m produce whatever rope tension may be desired; and the necessity of a deep shaft in which these weights may rise and fall is obviated by passing the free end of the rope through the sheave n and back on the right-hand end of the drum, so that as it is wound on the left or testing end it is unwound from the right or storage end, and vice versa.

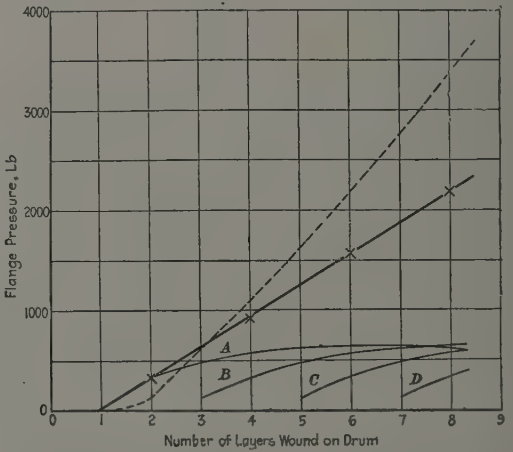

Fig. 7 Curves Showing Flange Pressure
(Rope pull, 256 lb.; rope, 1/4 in., 6 by 19; pitch of coils, 5/16 in.)

The following procedure was used in making the tests: The desired size of rope was attached to the drum, a sufficient length being used to fill the left end of the drum to the outside of the flange. One complete layer was wound on the testing end of the drum, the required spacing having been obtained by fiber liners placed between adjacent coils, at close intervals around the circumference of the drum body. It would, of course, have been possible to space the coils by grooving the drum, but this would have limited the apparatus to one size of rope. The desired weight was then placed on the hanging platform, and all was in readiness for a test run. In making a run the shaft was first turned a small amount, varying from 10 to 360 deg., during which time a portion of rope was wound upon the testing end of the drum; the bight of rope hanging below the drum was then given two or three smart hammer blows to cause the new coils to settle well in place, and the scale beam was balanced and reading recorded. This was repeated until the testing end was practically filled with rope. The small turning intervals, 10 deg., 30 deg. and the like, were used only for the coils near the loose flange, as practically all of the increase in axial thrust occurred when these coils were wound on. For the remaining coils, readings taken for each revolution of the drum were considered sufficient.

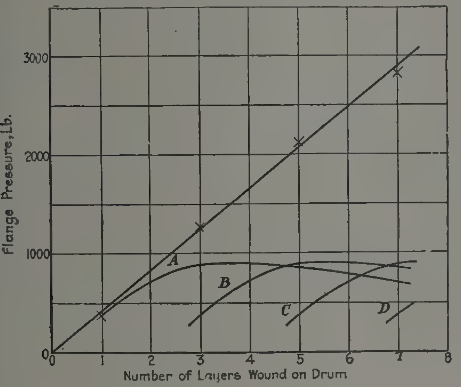

Fig. 8 Curves Showing Flange Pressure
(Rope pull, 256 lb.; rope, 1/4 in., 6 by 19; pitch of coils, 1/4 in.)

A marked periodic rise and fall in the scale readings occurred during each revolution of the drum. This was undoubtedly due to a slight camber in the shaft, with possibly some additional effect caused by untruth in the bearing surfaces x and y, Fig. 6, since the phase of this periodic change varied somewhat as the axial thrust increased. On account of its periodic nature, the error could be corrected by simply taking averages of the readings obtained during each revolution of the shaft.

TABLE 1 VALUES OF P' FOR VARIOUS LAYERS IN TERMS OF THE INITIAL TENSION P

Number of Layers	1					2				
h (see note)	0.6	0.7	0.8	0.9	1.0	0.6	0.7	0.8	0.9	1.0
P_1'/P	0.00	0.00	0.00	0.00	0.00	0.30	0.35	0.40	0.45	0.50
P_2'/P	..	..	..	..	..	..	..	..	..	..
P_3'/P	..	..	..	..	..	..	..	..	..	..
P_4'/P	..	..	..	..	..	..	..	..	..	..
P_5'/P	..	..	..	..	..	..	..	..	..	..

Number of Layers	3					4				
h (see note)	0.6	0.7	0.8	0.9	1.0	0.6	0.7	0.8	0.9	1.0
P_1'/P	0.13	0.13	0.13	0.13	0.13	0.05	0.04	0.04	0.03	0.03
P_2'/P	0.56	0.62	0.67	0.71	0.75	0.21	0.20	0.19	0.18	0.17
P_3'/P	..	..	..	..	..	0.62	0.67	0.71	0.75	0.78
P_4'/P	..	..	..	..	..	..	..	..	..	..
P_5'/P	..	..	..	..	..	..	..	..	..	..

Number of Layers	5					6				
h (see note)	0.6	0.7	0.8	0.9	1.0	0.6	0.7	0.8	0.9	1.0
P_1'/P	0.02	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
P_2'/P	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01
P_3'/P	0.23	0.22	0.20	0.19	0.17	0.08	0.07	0 05	0.05	0.04
P_4'/P	0.64	0.68	0.72	0.75	0.78	0.23	0.22	0.20	0.19	0.17
P_5'/P	..	..	..	..	..	0.64	0.68	0.72	0.75	0.78

Note: The value of h is given by the following formula., where a = area of wires in rope; E = modulus of elasticity of rope, E' = transverse modulus of elasticity of rope, m = coefficient of lateral deformation of rope, r = average radius of coils under consideration:

$$h = \frac{aE}{E'r^2}\left(\frac{\gamma}{45^\circ} - \frac{90^\circ - \gamma}{45^\circ} m\right)$$

Figs. 7 and 8 show the results of two of these tests in graphic form. In each figure, curve A indicates the flange pressure opposite the first layer, curve B the flange pressure against the third layer, etc. The heavy curve shows the total flange pressure, and the dotted curve gives the total pressure as computed by Formula [3]. A surprising difference in flange pressures is evidenced by a comparison of Fig. 7 with Fig. 8, where the rope pulls are the same, but the coils are wound close instead of being separated. The writer attributes this to a difference in the winding characteristics of the two cases: When the coils are separated to simulate the effect of a grooved drum, they are wound on in each layer in approximately helical form; but when they are closely packed, each coil is a true circle except for an arc of about 30 deg. in which space the advance to the position of the next coil takes place. This means that the arc of cross-over, in which the coils are self-sustaining, is longer for the space than for the closely packed arrangement of coils; hence the flange pressure is less. Furthermore the closely packed coils are in contact with each other at six points, instead of four points, per coil; consequently there is a less pronounced rope flattening in the interior layers, with a correspondingly higher flange pressure as a result.

This latter effect could be taken account of in Formula [3], by selecting the values of P'/P in Table 1 which correspond to higher values of the lateral deformation factor m. As the writer did not have the time to obtain experimental values of m, he considered it best to omit the theoretical curves from Fig. 8.

At least two conclusions may be drawn from the tests: First, the actual flange pressure increases, roughly, in direct ratio with the number of layers, whereas the theoretical pressure (neglecting friction and rope flattening) is represented by a curve with rising slope; so that at eight layers the actual is only a tenth or less part of the theoretical pressure. The plotted points in Figs. 7 and 8 might be taken to indicate a drooping curve for the actual pressure, but Fig. 9, where four additional layers are shown, points rather to a straight-line relation. Second, the results obtained with Formula [3], and shown in Fig. 7 by a dotted curve, show a fair degree of correspondence with the test curves, and err for the most part on the side of safety. In plotting the dotted curve, E' was taken at 9260 lb. per sq. in., m at 0.3, and μ at 0.2, all of which are high values. Lower values would be more truthful and would make a still closer agreement of the dotted curve with the test curves.

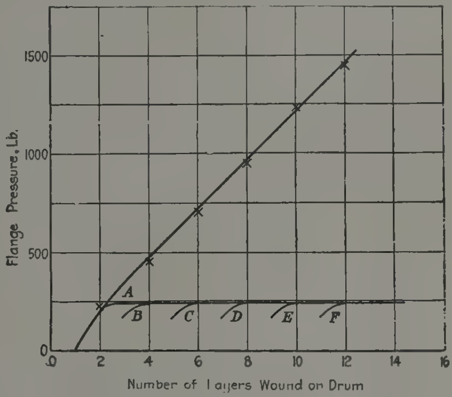

Fig. 9 Curves Showing Flange Pressure
(Rope pull, 56 lb.; rope, 1/8 in., 6 by 7; pitch of coils, 5/32 in.)

The question naturally arises: If the tests indicate a straight-line relation between the flange pressure and the number of layers of rope, what value is there in a complicated expression such as Formula [3], which brings in several indefinite quantities like μ, p, E' and m? The answer is that the tests show merely a few results from a very wide range of possible conditions; whereas the formula, by taking into account a large number of variables, should be applicable to all conditions, whether the number of layers, rope pull, coefficient of friction, etc., be large or small. The field is still open for further experimentation, using larger rope sizes and greater rope pulls, and the quantities E' and m should be accurately determined for different sizes and lays of rope. The writer hopes that this work can be undertaken in the near future, and that the results will stand as an additional check upon the theoretically derived relation between rope pull and flange pressure embodied in Formula [3].

Steam vs. Electric Locomotives

Joint Meeting in New York for the Discussion of the Relative Advantages of Modern Steam and Electric Locomotives Has a Record Attendance—Papers and Discussion by Leading Authorities in the Railroad Field

A CONTROVERSIAL subject, if timely, always draws a crowd. On the evening of October 22, in the Engineering Societies Building, New York, the controversial subject was provided and the crowd was there. The meeting was under the joint auspices of the Professional Section on Railroads of the A.S.M.E., the Metropolitan Section of the A.S.M.E. and the New York Section of the A.I.E.E.; and the subject was Steam vs. Electric Locomotives. The attendance was a record-breaking one—every seat in the large auditorium was taken, 200 were standing and 400 or 500 were turned away. The curtain raiser was by Frank J. Sprague, the father of electric railroading, who briefly reviewed certain features connected with the development of electric railroads and the electric locomotive, after which were given the three papers of the evening, followed by the discussion which lasted until nearly midnight. The brief (in the legal sense) for the steam locomotive was presented by John E. Muhlfeld, vice-president, Railway and Industrial Engineers, Inc., New York, and the case for the electric locomotive was presented by A. H. Armstrong and F. H. Shepard, representing respectively the General Electric and Westinghouse companies. The discussion was summed up by George Gibbs, consulting engineer, Pennsylvania Railroad. Space permits the publication of abstracts only of the three papers and a running account of the discussion.

Remarks by Frank J. Sprague

Mr. Sprague, in tracing the history of railway electrification in America, read a news item from a copy of the New York *Sun* published in August 1887, recording the trial of an electric car on Fourth Avenue, New York, which it said "created an amount of surprise and consternation from 32d Street to 117th Street that was something like that caused by the first steamboat on the Hudson." Soon after came the famous Richmond, Va., road, fairly called the forerunner of the modern trolley. Three years later there were in operation, here or abroad, something like 350 electric trolley roads and a quarter of the street-tramway mileage of the United States had been converted to the new power.

The speaker said that so successful had been the early application of electricity to this particular problem that the wildest prophecies were made by imaginative enthusiasts of the coming debacle of the steam railway, and he found it necessary, as the incoming president of the American Institute of Electrical Engineers, in June 1892, to sound a warning in his inaugural address on the subject of The Coming Development of Electric Railways.

At that time the problem of trunk transportation was still awaiting solution and had to be preceded by another and more pressing development, that of urban rapid transit. In New York the "L" was supreme and the growth of the city was being throttled. The handicap of steam equipment had been only partially removed, and only when it became possible absolutely to disregard it and, instead, to adapt equipment and methods of operation to the possibilities of electric operation, was the success of rapid transit assured. Then were the city's shackles cast off and the modern growth of the great metropolis made possible. It was even then, however, a long time before the multiple-unit system, the fundamental of electric rapid transit the world over, received recognition.

Preliminary to the larger developments in the broad field of trunk-line operation was the construction in the early 90s by Drs. Duncan and Hutchinson, and Mr. Sprague, with the help of the Baldwin and Westinghouse companies, of a 1000-hp. electric locomotive, which, however, never saw service. Handicapped as was the transmission of power on a large scale and over long distances, until the development of the a. c. transformer and the rotary converter, and by the persistent traditions of steam practice, progress was necessarily impeded, and it was not until about 1902 that because of a grave accident the New York Central Railroad undertook its epoch-making development of a great terminal and the beginning of trunk-line operation.

Looking to the future, Mr. Sprague said: "I wish to record again my unchanging belief in the coming supremacy of electric power for transportation; and, propagandist as I have been these many years, my faith is based not upon any overwhelming claims of superior fuel economy when both are dependent on coal supply, nor upon any material saving in operating expense sufficient to pay the charges incident to the increased capital cost when considered on existing traffic density and methods of operation, but rather upon the broad ground of the overwhelmingly vital demand for *increased capacity*, a demand which ultimately can be met only by the electric system because of characteristics individual to it.

"Of course, the general electrification of trunk lines is not a matter of immediate possibility of accomplishment. It will only come as it is coming, progressively with the accelerating power of example. It will be governed very largely by financial conditions, however justified. Under sufficiently enlightened public policy, railroads might be able to assume the large added burdens incident to electrification, if given sufficient encouragement. But the test of wisdom of railway officials, financiers, and national and state governments is the ability to anticipate and plan against the inevitable before the slowing down and paralysis of traffic, such, for example, as is illustrated by the rapid-transit situation in this city, where the congestion affects the daily life and wellbeing of the whole community.

"I am not unmindful of the many and great difficulties in the way of accomplishment, nor would I have electrical engineers lose themselves in visionary contemplation of unobtainable commercial realities; but I may perhaps repeat the substance of the closing words of that address of 28 years ago, to which I have already referred:

" 'Such is the work before you, a work well meriting your best effort. Yet it is well to temper your effort with prudence. Limit your attempts to the solution of those problems which will promise practical benefit. Do not chase rainbows; they are beautiful and poetic, but they have small place in the world's economies.'

"This is said in no spirit of discouragement, for I yield to no man in my confidence in the future of electricity."

Steam vs. Electric Locomotives—the Steam Side

By JOHN E. MUHLFELD, NEW YORK, N. Y.

IN consideration of the existing traffic rates and regulations as established by the Interstate Commerce Commission, and the wages and working conditions as recommended by the Railroad Labor Board, it is assumed that the railroads as a whole will average net operating earnings equal to 6 per cent on their valuation as fixed from time to time by the Interstate Commerce Commission. Some railroads may earn more and some will earn less, but in every case the minimum fixed charge and the maximum operating and maintenance economy will be required if the stock owners are to receive even a reasonable return on their investments.

In the protection and control of railroad net earnings one of the most involved factors is the kind of motive power to be used, and, unfortunately, in appraising the relative values of steam and electric railway power, comparisons have been made between the operations of new, up-to-date electrical and of obsolete steam installations; or on the basis of other conditions which are not fairly comparable.

For example, a report was made several years ago on the advisability of electrifying about 275 miles, or a division, of one of the more prominent western lines, and an erroneous comparison was made, first, between existing antiquated and uneconomical steam and an up-to-date electric operation; and second, by omitting a statement of the investment required to bring the steam operation up to date. When all involved factors were properly adjusted the net capital expenditure of $4,000,000 required for electrification (compared with $1,000,000 needed for modernizing the steam equipment), and the estimated annual operating saving from electrification of approximately $750,000, were wiped out and replaced by a saving of $250,000 from a continuation of the improved steam operation.

When we discuss the further electrification of the whole or any part of the 260,000 miles of steam-operated railroad systems in the United States, which is now making use of about 65,000 steam and 375 electric locomotives for its passenger, freight and terminal service, the most essential requisite is a correct and complete statement of facts, comparing the most up-to-date steam operation with similar electric operation, after which immediately come the important factors of the necessary financing and legislation.

Financing. Few if any existing steam roads can justify the additional capital investment required per mile of road for electrification, except for short distances under very special conditions such as prevailed on the Norfolk and Western, where the ventilation and 1.5 per cent grade line features of a five-eighths-mile single-track tunnel restricted the train movements to a 6-m.p.h. basis on a congested traffic section of the main line, and even then only providing the fixed charges and operating expenses are not too excessive.

The immediate requirements of new money for the more urgent steam equipment and facilities needed to provide adequate, safe and expeditious rather than luxurious service in the regeneration of the railroads, is the obvious reason for the continued utilization of the overall more economical steam operation; and only after the possibilities in this direction have been realized can any serious financial consideration be given to the proposed radical change to superelectrification.

Adaptability to Existing Trackage and Facilities. First and foremost in the advantages of a continuation of the existing improved steam locomotive for all purposes for which it is permissible, is its flexibility and adaptability to existing railroad trackage and terminal and operating facilities, and the relatively low first cost at which it can be purchased per unit of power developed for the movement of traffic. Being a self-contained mobile power plant, it is possible quickly to transfer needed or surplus power from one part of the line to another and to concentrate it when and where necessary; whereas, with the electric locomotive this is impossible unless electrification extends over the entire property or the sources of power supply have almost prohibitive peak-load capacity. Furthermore, the various systems of electrification make the interchanging of electric locomotives impracticable without much non-productive first cost, complication, and maintenance and operating expense.

Effectiveness in Increasing Track Capacity. Without doubt electrification increases the capacity of a terminal, as evidenced by the intensified traffic movements at Grand Central Station in New York, and at Broad Street Station in Philadelphia; but an analysis of the situation on the New York Central shows that this is not due to decreasing locomotive movements through the use of multiple units as is usually stated. For example, through-line passenger trains are handled in and out of Harmon with single steam the same as with single electric locomotives; and as regards commutation service, this is largely a motor-car proposition, as indicated by the fact that the New York Central has 241 motor cars (and no trailers) as compared with 73 electric locomotives.

Special line conditions, as on the Norfolk and Western, may make electrification advisable for short distances, but neither the results on that road nor at the New York terminals justify the assumption frequently made that electrification would have obviated the difficulties experienced in steam-locomotive haulage during the unprecedentedly cold weather and severe traffic conditions of the winters of 1917–1918. If otherwise, why did the New Haven not operate at 100 per cent of its capacity over its electrified zone at that time? If short of locomotives or motor cars the New York Central had plenty of surplus that was not in use and which could not be utilized outside of its electric zone where it was badly needed. The probable answer is lack of interchangeability, which is still one of the most discouraging operating factors involved in any electrification scheme, as brought out in the last report of the A.R.A. Committee on Design, Maintenance and Operation of Electric Rolling Stock, wherein the wide variation of current-generating, transmitting, distributing and contact systems, voltages, types of locomotives and of general ideas relating to the features sets forth the present undeveloped state of the art.

Furthermore, in the handling of heavy-tonnage trains by the unlimited combining of electric-locomotive units, the factors of peak load, transmission lines, and power-plant capacity must all be considered, with the probability that permissible modern steam-locomotive train units can be more economically handled over dense traffic lines than the electric multiple-unit super-trains. Although under the multiple-unit system of locomotive and train operation it is theoretically possible to provide unlimited sustained hauling capacity at the head of the train, the tonnage to be handled without rear-end or intermediate helpers is limited by the ability of the draft rigging on the cars to withstand the pull and shock. This limitation can be readily met and exceeded in steam-locomotive design and operation, as may be noted from the following comparison of the St. Paul electric freight and the Virginian steam freight articulated types of locomotives:

TABLE 1 COMPARISON OF MODERN TYPES OF ELECTRIC AND STEAM LOCOMOTIVES

	St. Paul Electric Articulated	Virginian Steam Articulated
Tractive power, in simple gear, maximum	132,500 lb.	176,600 lb.
Tractive power, in compound gear, maximum	....	147,200 lb.
Tractive power, at 15 miles per hour	71,000 lb.	108,000 lb.
Wheel arrangement (excluding tender)	4–8–8–4	2–10–10–2
Length over all (including tender)	112 ft.	107 ft.
Total wheelbase (including tender)	102 ft. 8 in.	97 ft. 0 in.
Driving wheelbase	75 ft. 0 in.	64 ft. 3 in.
Rigid wheelbase	10 ft. 6 in.	19 ft. 10 in.
Total weight on driving wheels	448,000 lb.	617,000 lb.
Total weight on truck wheels	116,000 lb.	67,000 lb.
Total weight of tender (with 1/2 fuel and water capacity)	....	148,000 lb.
Total weight of locomotive	564,000 lb.	832,000 lb.
Truck wheels—total No.	8	4
Driving wheels—total No.	16	20
Driving wheels—diameter	52 in.	56 in.
Driving wheels—adhesive weight to total	79.4 per cent	90 per cent
Driving wheels—adhesive weight per axle, avg.	56,000 lb.	61,700 lb.
Driving wheels—unsprung weight per axle, avg.	16,250 lb.	12,000 lb.
Factor of adhesion—maximum tractive effort	3.38	3.49
Factor of adhesion—tractive effort at 15 m.p.h.	6.31	5.70
Source of power	Electricity from outside hydro-electric plant	Superheated steam from self-contained boiler plant

Train Speeds. The averge freight car is in main-line movement only about 10 per cent of its life, or 2 hr. 24 min. out of each 24 hr. The balance of its time can be distributed as follows: 55 per cent in the hands of the railroads on account of interchanges, yard and loading and unloading track movements, surplus cars, repairing tracks, and road delays; and 35 per cent in the hands of the shipper and consignee, due to loading and unloading reconsignment and Sundays and holidays. Therefore, increasing train speeds beyond established economic limits at the sacrifice of tonnage, and with an increase in fuel, track and equipment upkeep and danger of operation, is not the solution of the freight-traffic problem. For example, an increase of 50 per cent over and above the established economic freight-train speeds would be only 72 min. of the daily life of each freight car; whereas, capital expenditures applied to the reduction of those delays which now involve, over $21^{1}/_{2}$ hr. per day, or about 90 per cent of the life of the car, would give much more effective and economical results.

As the electric locomotive is a constant-speed proposition, whether going up or down grade, and is unable to utilize its rated capacity and effectiveness through the same range of speed and tractive-power variations as the more flexible steam locomotive, the latter can, therefore, be more efficiently operated over the continually changing up and down grades, levels, curves and tangents traversed by the average freight train in this country.

With respect to passenger-train service, where speed is more of a factor, the steam locomotive performs equally satisfactorily. For example, on the main line of the Baltimore and Ohio, for a distance of 17 miles between Piedmont, West Virginia, and Altamont, Maryland, the average gradient is 2.2 per cent. A single Pacific-type locomotive with a tractive power of 43,400 lb. will haul up this grade in 50 min., without helper, or at an average speed of 20 m.p.h., a passenger train consisting of 9 cars weighing 620 tons without locomotive and 830 tons with locomotive. The same train will make the trip down grade in 35 min., or at an average speed of $28^1/_2$ m.p.h. The total weight of engine and tender of these Pacifics is 210 tons, which may be compared with a total weight of 265 tons for the St. Paul electric locomotives used to handle similar passenger trains up 17 miles of 2.2 per cent grade from the Columbia River west at an average speed of 25 m.p.h.

Fuel Consumption. [Under this heading the author refers to figures which have been quoted in support of electrification on the basis of a coal rate of $2^1/_2$ lb. per kw-hr. at the central station in combination with a 40-kw-hr. rate at the point of delivery of the power to the railroad system, resulting in a train movement of 1000 average gross ton-miles for 100 lb. of coal of about 12,000 B.t.u. In commenting on this, he says that in arriving at these data apparently numerous factors were overlooked or disregarded which should be included in any estimate of the power requirements and coal rates for an electrified system. Continuing, he says:]

However, accepting the assertion that the proposed electrification will produce 1000 gross ton-miles for an average of 40 kw-hr., or 100 lb. of 12,000-B.t.u. coal, as stated and generally approved by electrical engineers, what can the modern steam locomotive do to justify its existence?

Dynamometer-car tests may be cited, made by a Joint Committee of representatives of the New York Central and Pennsylvania railroads and the American Locomotive Company during August 1910, of the first Mallet-type of locomotive put into use on the Pennsylvania Division of the New York Central and operated over the 65 miles of average 0.5 per cent grade line between Avis and Wellsboro Junction. This locomotive was built ten years ago and by no means represents the best practice of the present day when superheat has been increased and a more efficient all-around machine is produced. At that time the average of six runs gave a thermal efficiency of 6.01 for the locomotive, and the following test made on August 27, 1920, is representative:

Miles run, about	65
Cars in train, No.	65
Cars in train, tonnage	3,734
Running time	4 hr. 35 min.
Time on road	6 hr. $51^1/_2$ min.
Average speed, m.p.h.	12.9
Thermal efficiency of locomotive	6.25 per cent
Dry coal per drawbar horsepower-hour	2.90 lb.
B.t.u. in dry coal as fired	14,053
Cut-off	....
Drawbar horsepower	1,270.4
Drawbar pull	34,071 lb.
Steam pressure in branch pipe	203.3 lb.
Superheat in branch pipe	143.7 lb.
Machine efficiency of locomotive	89.21 per cent
Boiler efficiency	69.07 per cent

Furthermore, the 2–6–6–2 type Mallet steam locomotives with tractive power of about 88,500 lb. in compound, and 106,200 lb. in simple gear, operated over a distance of about 155 miles of average 0.3 per cent grade line with a ruling grade of 0.6 per cent 13 miles long, between Birmingham, Ala., and Columbus, Ga. During this period steam was used about 50 per cent of the time, the locomotive drifting the balance of the time, and a figure of 1000 gross ton-miles was realized from 106 lb. of coal of approximately 13,000 B.t.u. which compares quite favorably with the foregoing hypothetical figures given for electric operation.

The results of some dynamometer-car tests made during 1918 may also be of interest. At that time the steam locomotives tested were of the ordinary superheated Mikado freight type of the following general description:

Weight on driving wheels	110 tons
Weight on truck wheels	32 tons
Cylinders, simple	25 in. by 32 in.
Driving wheels, diameter	56 in.
Steam pressure	200 lb.
Tractive power	59,600 lb.

One locomotive was fitted for hand firing and burning coal on grates, while another was equipped with the "Lopulco" system for burning powdered coal in suspension, and the tests were made in tonnage freight service handling from 2400 to 2600 tons eastbound and from 1850 to 2250 tons west-bound on the Santa Fe main line between Ft. Madison, Ia., and Marceline, Mo. (the profile consisting of 0.8 per cent ruling grades) a distance of 112.7 miles. The coal averaged from 1 to 8 per cent moisture, 33 to 38 per cent volatile, 51 to 41 per cent of fixed carbon, 15 to 12 per cent ash, 4 to $3^1/_2$ per cent sulphur, and from 12,055 to 11,050 B.t.u. as fired. The comparative average results are given in Table 2.

TABLE 2 TESTS ON MIKADO FREIGHT-TYPE SUPERHEATER LOCOMOTIVES

	Powdered-Coal Locomotive	Hand-Fired Locomotive
Total trips run (112.7 miles each)	14	10
Total miles run	1578	1127
Average running time, hours	5.06	5.25
Average dead time, hours	1.25	1.01
Average total time, hours	6.31	6.26
Average speed, m.p.h.	22.3	21.6
Average trailing tonnage per train	2278	2283
Average gross 1000 ton-miles	256.5	255.4
Average coal per gross 1000 ton-miles	82.4	114.8
Average superheat, deg. fahr.	223	173
Average coal per boiler and superheater, coal per hp-hr.	3.74	4.99
Average B.t.u. per pound of coal as fired, lb.	12,025	11,160

As the coal supplied to the grates of the hand-fired locomotive was considerably lower in heat value than that specified in the electrification project, and as the tests were run during March and April, it can be assumed from the foregoing that the average yearly performance will approximate 100 lb. of 12,000-B.t.u. coal per 1000 gross ton-miles, or equivalent to what we are promised for the expenditure of billions of dollars of new capital and the loss of billions of dollars of investment in existing plant and equipment to inaugurate electrification.

Efficiency of Locomotive Operation. It is unquestionably true that when operating under ideal fixed-load conditions, the central power station, either hydroelectric or steam, can produce a horsepower with less initial energy input than is possible on a steam locomotive. It is also true that the stand-by losses on existing steam locomotives are, in ordinary practice, a serious proportion of the total fuel consumption; but it is likewise a fact that the majority of these can be substantially reduced, if not entirely overcome, by modernizing the present equipment and improving maintenance and operation.

The number of factors entering into an analysis of the net thermal efficiency of the electric locomotive, in terms of drawbar pull, are so many as to make it impossible with the lack of dynamometer-car and laboratory test data to arrive at a figure which is not based on a number of assumptions; but as a matter of interest, assuming, that *all of the factors are affected equally* in the electric locomotive, the net thermal efficiency at the drawbar, when taking into consideration the boiler, engine, generator, step-up transformer, a.c. transmission, step-down transformer, a.c.-d.c. converter, d.c. transmission, motors, and machine efficiencies may, as representative of average existing practice, be illustrated as in Table 3.

TABLE 3 ANALYSIS OF NET THERMAL EFFICIENCY OF ELECTRIC LOCOMOTIVE

		Load Rating, Per Cent		
Equipment:		100	75	50
Boiler	Factor	...	...	....
	Efficiency	76.7	76	72
Engine	Factor	18.25	18.29	19.17
	Efficiency	14	13.9	13.8
Generator	Factor	90	89.5	86
	Efficiency	12.6	12.44	11.88
Transformer, Step-Up	Factor	98	96	90
	Efficiency.	12.34	11.93	10.67
Transmission, A.C.	Factor	90	95	97
	Efficiency	11.10	11.32	10.34
Transformer, Step-Down	Factor	98	96	90
	Efficiency	10.87	10.85	9.30
Converter, A.C. to D.C.	Factor	80	75	63
	Efficiency	8.69	8.13	3.85
Distribution, D.C.	Factor	90	95	97
	Efficiency	7.82	7.71	5.66
Motors, D.C.	Factor	91.5	90.8	89.5
	Efficiency	7.15	7.00	5.05
Machine Efficiency	Factor	81	85	90
	Efficiency	5.79	5.95	4.54

Likewise the net thermal efficiency of existing representative steam locomotives, in terms of drawbar pull, may be illustrated as in Table 4.

TABLE 4 ANALYSIS OF NET THERMAL EFFICIENCY OF STEAM LOCOMOTIVE

			Load Rating, Per Cent		
Equipment:	Steam Used:		100	75	50
Boiler..........	Superheated	Factor	...	...	...
		Efficiency	42.7	54.9	65.9
	Saturated	Factor	...	...	...
		Efficiency	45.0	57.4	70.0
Cylinders.......	Superheated	Factor	11.9	11.0	10.5
		Efficiency	5.08	6.04	6.92
	Saturated	Factor	7.8	8.4	7.8
		Efficiency	3.51	4.82	5.46
Machine........	Superheated	Factor	75	80	85
		Efficiency	3.85	4.83	5.86
	Saturated	Factor	77	80	82
		Efficiency	2.70	3.86	4.47

Comparing the electric and steam locomotive figures as illustrated, the relative percentage of power delivered at the track rails to 100 per cent B.t.u. in the coal would be as given in Table 5.

TABLE 5 COMPARISON OF THERMAL EFFICIENCY OF ELECTRIC AND STEAM LOCOMOTIVES

	Net Thermal Efficiency at Load Ratings of		
Kind of Locomotive:	100 Per cent	75 Per cent	50 Per cent
Electric	5.79	5.95	4.54
Steam, Superheated	3.85	4.83	5.88
Steam, Saturated	2.70	3.86	4.47

As 100 per cent load rating conditions would, in practice, occur only momentarily and as the majority of the drawbar load represents from 30 to 60 per cent of the locomotive maximum drawbar capacity, comparison should be properly made only of the net thermal efficiencies at 50 per cent load ratings.

[As a check on the foregoing figures upon steam operation, the author presents a table (not here published) in which is given the results of tests on representative types of steam passenger and freight locomotives. In respect to these he says:]

It will be noted that at speeds of from 15 to 75 miles per hour the thermal efficiency of existing superheated-steam locomotives actually ranges from 5.3 to 8.1 per cent as compared with the calculated figures of from 4.83 to 5.88 per cent for 75 and 50 per cent load ratings, respectively. Adding to this an increase of from 15 to 50 per cent in net thermal efficiency that may be produced from the various developments now under way and the steam locomotive of the future will be quite a respectable assembly of engineering efficiency.

Cost of Enginemen. Under existing conditions each electric locomotive must carry a motorman, and a second man comparable to the fireman of a steam locomotive, although not functioning as such. The wage of the latter is an added expense without economic return and must be charged to the cost of firing the central power-station boilers or otherwise distributed.

Cost of Maintenance. In determining the maintenance cost of the electric locomotive, a true comparison can only be made by including all elements corresponding to those found in the self-contained steam locomotive, which goes back to the upkeep of all facilities having to do with the utilization of the fuel or water power, including the central power-station buildings; boilers; engines; conversion, transmission, distributing and contact-line systems; substations; track rail bonding and insulation; electric disturbance cutouts or neutralizers; extra expense in upkeep of the electric zone trackage; and like auxiliaries, and finally the electric locomotive itself.

With particular reference to the maintenance-cost figures that have been given as applying to the New York Central, Michigan Central, Pennsylvania and St. Paul railroads for the years 1913 to 1918, inclusive, and which range from $3.78 to $10.87 per 100 locomotive-miles run, these no doubt apply to the electric locomotive units only, and if so would appear exceptionally high even for relatively new-built steam locomotives. Until a true reflection of the upkeep cost per electric locomotive, or per 1000 gross ton-miles hauled, can be given by including all the factors and elements of age and mechanism that are embodied in the steam locomotive, comparisons will be worthless.

Peak-Load Conditions in Relation to Traffic Requirements. In order to meet the ideal conditions for electrification, the traffic should be uniformly scattered over the 24-hr. period, whereas in the majority of cases train movement is based on traveling and shipping conditions and cannot be advanced or delayed in order to eliminate peak-load conditions. That this cannot be done in order to maintain a straight-line power demand can be illustrated by citing the condition that exists in any large industrial center where freight accumulates and is switched during the day period and the out and inbound train movements concentrate in fleets, principally in the evening and morning, respectively, and cause peak-load requirements at those times.

Ease of Starting Trains. Due to the uniform torque as developed by the electric locomotive, its adherents have laid great stress on its ability to start a heavier train than a steam locomotive of relatively the same tractive power and factor of adhesion. In steam-railroad service the locomotive is seldom required to start "the train," but what it does is to start each car in the train, successively, which nullifies this theoretical advantage of the electric locomotive. In fact, with steam locomotives of the Mallet and other types having compound cylinders equipped with properly designed simpling devices, the starting power is increased about 20 per cent as compared with electric locomotives of equivalent road rating.

Rate of Acceleration. In order that the desired running speeds can be reached in the minimum time after the starting of trains, the ability of a locomotive to rapidly accelerate its load is of considerable importance, and in this respect the electric power has had the advantage. The steam-locomotive engineer, however, has not lost sight of this fact and improvements already made in boiler and cylinder horsepower ratios, as well as developments now undergoing for utilizing existing non-productive adhesive weight and increasing the coefficient of friction between the propelling wheels and the track rails will enable the steam locomotive to duplicate the performance of its electric competitor in this regard.

Train Braking. Since the development of regenerative braking with the electric locomotive, great emphasis has been laid on the increased security of operation which this permits over heavy-grade lines. Considerable attention has also been directed to the saving brought about through the elimination of the ordinary air braking on such down grades.

The Baltimore and Ohio has successfully and safely handled with steam locomotives its heavy tonnage and dense traffic on the Cumberland and Connellsville Divisions for many years, and this tonnage descends a grade averaging approximately 2.2 per cent for 17 miles, at an average speed of from 15 to 20 miles per hour for freight and from 25 to 30 miles per hour for passenger trains, without slow-downs or stops. This performance is comparable with that on the worst grade conditions encountered in the St. Paul electrified zone.

While the regenerative system of braking can no doubt be developed to the point where it can be safely used, the recent serious accident on the St. Paul wherein a heavy-tonnage freight train made up with an electric locomotive at the head end and a steam Mallet helper locomotive at the rear end, broke away from the latter and derailed the entire train of about 65 cars on a 20-mile grade of 2.2 per cent, due to the failure of the regenerative brake control, makes problematical just what economy will result. When the power so generated cannot be directly used by another pulling locomotive on the line, it must be otherwise absorbed, and it remains for the electrical engineers to prove just how much of it is lost in conversion or by absorption and the resulting net gain as compared with the investment, fixed charge and upkeep and operating cost for the equipment involved.

Effect of Weather Conditions. Even though the full steaming capacity, horsepower, and drawbar pull of a modern steam locomotive can be developed during cold-weather conditions, there are the factors of radiation and freezing to be reckoned with, which gives the electric locomotive the advantage in winter, particularly as its effectiveness is greater on account of the lesser tendency for the motors to overheat. This winter advantage, however, is largely overbalanced during the summer when the main motors heat, especially under overloads, and require cooling at terminals; or by overheating lead to insulation breakdowns, burn-outs, or other troubles.

Road Delays and Tie-Up. While the electric locomotive has the advantage of not being required to take on fuel and water except for the operation of steam-heating equipment for passenger trains, with the increased capacity of the modern steam-locomotive tenders, and the lower water and fuel rates per drawbar horsepower developed, the delays due to taking on these supplies have been greatly reduced and need not be serious.

Barring collisions, wrecks and like accidents not due to the system of motive power in use, steam operation is not susceptible to complete tie-ups as is the case with electrification, where short-circuits or failures occur due to rains, floods, storms and like causes, and as the result of motor, wiring and insulation heating, deterioration and breakdowns, as the individual mobility of each piece of motive power without regard to any outside source of power enables quick relief.

Terminal Delays. The examination of reports of a dense heavy-freight-traffic railroad in the Eastern District shows the time of its steam locomotive for a recent two months' period distributed as follows:

1	In road service	50 per cent of total time
2	At terminals waiting trains and otherwise in hands of transportation department	26.4 per cent of total time
3	At terminals in hands of mechanical dept.	23.6 per cent of total time

There is no doubt but that the electric has an advantage over the steam locomotive as regards time required for periodical boiler work, fire cleaning and rebuilding, fueling and watering except where fuel oil is used, but where terminal delays occur due to waiting for trains, the time required for such work does not become an expensive determining factor in the daily average miles to be obtained per locomotive.

Steam vs. Electric Locomotives—the Electric Side

By F. H. SHEPARD,[1] PITTSBURGH, PA.

THE limit to physical expansion of railroad lines and of terminals has been just about reached in many cases, both on account of the prohibitive cost and the inefficiency of terminals of unworkable size. A large measure of relief can still be secured by line and terminal revisions and improvements, but when the inevitable increase in the demand for traffic movement of the future is considered, these improvements savor more or less of expedients to secure relief which can only be temporary and very limited in degree.

The great need of the country (and this is coming to be more and more generally understood) is the free and expeditious movement of our traffic. The yearly average of 22 miles per day for a freight car for the whole country, with monthly averages of as low as five miles on some of our most congested railroads for a single month, emphasizes the fact that this is a problem that somehow, someway, we must solve. The solution lies to a large extent in railroad electrification.

With the present standards of train make-up, classification and terminal handling, electrification will double the capacity of any railroad. With the better equipment we can expect in the future, together with the evolution of improved methods of operation contingent on electric power, this capacity should be doubled again, thus securing four times the present capacity. This should certainly be accepted as a vision of the future, and why not our aim? Unless some broad and consistent program is embraced, the situation, which is serious indeed today, may well be calamitous tomorrow.

The electric locomotive has generally, thus far, been a mere substitute for the steam locomotive, although in some cases, due to the greater power of the electric locomotives, there has been modification of the handling of traffic.

Two conspicuous cases of this have been the Norfolk & Western and the Chicago, Milwaukee & St. Paul. In the case of the Norfolk & Western, two electrics handle the same train as was formerly handled by three Mallet engines, but at twice the speed. In this operation, owing to the great increase in hours of road service as well, one electric locomotive is the practical equivalent of four of the Mallet engines replaced.

On the Chicago, Milwaukee & St. Paul the notable change has been elimination of intermediate terminals on the electrified section between Harlowton, Montana, and Avery, Idaho, 440 miles long. There is at present a single intermediate engine terminal, but the latest passenger locomotives are detached from trains at this terminal for inspection and work only, about once in each eight or ten trips. On regular schedule these engines make a run of 440 miles each day, being taken off for inspection at Deer Lodge after mileage varying from three to five thousand miles. On occasion, when due to a schedule derangement engines have been maintained in continuous road service for periods of 30 hours for a full day of 24 hours, mileage records of up to 766 miles in this mountain service have been established.

The advantage of electric power is its great flexibility and mobility. The difference between locomotives, steam and electric, is fundamental. The steam locomotive carries its own power plant, while the electric locomotive, on the other hand, is simply a transformer of power. The design of the steam locomotive is circumscribed utterly by the necessity of tying up the rest of the machine to a steam boiler. On the other hand, the electric locomotive assembly can differ amazingly as to type, length, axle loading and driving connections. A group of small motors does not differ materially in efficiency from a single large motor. The speed and power of an electric locomotive, therefore, is limited only by conditions of track and construction and condition of car equipment. It thus becomes entirely practicable to build an electric locomotive to take any train which will hold together, over any profile whatever, and at any desired speed. It should easily be practical to increase very greatly the speed of our freight trains so that they would all run at a common speed not very different from that at which the superior trains are operated.

Again, with the retirement of the lighter and weaker car equipments, a material increase in the weight of trains will be realized. Without the limitation in train speed commonly accepted as a handicap to operation of tonnage trains, who can say what the limit to train load will be with electric power? In fact, the character of railroad operation which may be secured with electric power has not yet been visualized. Every other industry that has been electrified has experienced a revolution in methods and service due to electrification. This should be equally true in the case of the movement of our railroad traffic.

Our present methods have been built up entirely under the necessities and limitations of the steam locomotive. This is evidenced by the existence of intermediate terminals at the ends of all the so-called engine districts, where all traffic halts. Again, the steam locomotive requires attention en route, needs supplies of water and coal, and because of its slow movement when hauling our present tonnage trains, it is frequently sidetracked for superior trains, and thus there are more and still more halts to traffic.

Car inspection now takes place at the terminus of each engine district. If under condition of electric operation the engine district can be increased to 200, 400 or even 500 miles, is there any good reason why car inspection should not be eliminated at the present intermediate terminals? In fact, is not the general standard of maintenance of equipment of doubtful value on the present basis of inspection at each 100-mile interval? Cars in subway service, which is certainly full of potential hazard, are economically and reliably maintained, although inspected at intervals of one to three thousand miles. The elimination of these intermediate terminals, with the resultant necessity of keeping the train moving on the main line, would secure an enormous increase in miles per car with a corresponding saving in equipment.

Furthermore, with the dispatch obtained in handling trains, movement could be so marshalled and scheduled that the necessity of storing goods at terminals to protect exports and local consumption would be largely eliminated, and terminals would then become, in fact as in fiction, open instead of closed gateways.

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[1] Director of Heavy Traction, Westinghouse Electric and Mfg. Co.

[The author here introduced a general statement upon the comparative performance of steam and electric locomotives which is omitted in this abstract in view of the fact that Mr. Armstrong's paper is devoted largely to this phase of the subject and covers the ground quite thoroughly.—Editor.]

There are a considerable number of different designs of electric locomotives all in successful operation, and each possessing certain advantageous features. Further experience will undoubtedly result in the survival of common types for the different classes of service. The great latitude with which electric locomotives can be designed, while fundamentally most desirable, is in itself at the present time somewhat of a handicap. This is now the subject of intensive analysis and this study will undoubtedly develop a better knowledge of the running characteristics of the steam locomotive.

To state the case briefly, we are all interested in the transportation problem. Electrification is bound to be the most potent factor for its relief. We should therefore invite and embrace the closest coöperation with the engineering and mechanical skill which has been so productive in the steam-locomotive field.

Steam vs. Electric Locomotives—the Electric Side

By A. H. ARMSTRONG,[1] SCHENECTADY, N. Y.

A COMPARISON of the modern steam and electric locomotive leads immediately to a discussion of the relative fitness of the two types of motive power to meet service conditions. At present railway practice has closely followed steam-engine development, but are we not justified in looking at the transportation problem from the broader standpoint of a more powerful and adaptable type of motive power?

It is not merely a question of replacing a Mikado or Mallet by an electric locomotive of equal capacity. The economies thus effected are in many instances not sufficient in themselves to justify a material increase in capital account. The paramount need of our railways today is improved service, and this can be brought about by introducing the more powerful, flexible and efficient electric locomotive.

Possibilities of Design

Owing to handicap of precedent and prejudice, electricity must take up the railway problem where steam leaves off. In other words, the proof is up to the electrical engineer proposing any marked departure from commonly-accepted standards as established by long years of steam-engine railroading.

The following table gives the commonly accepted constants in locomotive design. While a maximum standing load of 60,000 lb. per axle has been generally accepted for steam engines, it is well known that an impact of at least 30 per cent in excess of this figure is delivered to rail and bridges due to unbalanced forces at speed. Impact tests taken on electric locomotives of proper design disclose the feasibility of adopting a materially higher limiting weight per axle than 60,000 lb. without exceeding the destructive effect on track and road-bed now experienced with steam engines. However, owing to the flexibility of electric locomotive design, there is no immediate need of exceeding present steam practice in this respect, although this and other reserves may be called upon in the future.

Commonly Accepted Constants

Limiting gross weight per axle	60,000 lb.
Limiting dead weight per axle	18,000 lb.
Limiting coefficient adhesion running	18 per cent
Limiting coefficient adhesion starting	25 per cent
Ruling gradient	2 per cent
Maximum curvature	10 deg.
Maximum rigidwheel base	18 ft.
Maximum speed on level—passenger	65–70 m.p.h.
Maximum speed on level—freight	25–30 m.p.h
Maximum drawbar pull	150,000 lb.

Accepting the Mikado and Mallet as the highest developments of steam road and helper engines for freight service, the following general comparison is drawn with an electric locomotive that it is entirely practicable to build without in any respect going beyond the experience embodied in locomotives that are now operating successfully.

Comparison of Steam and Electric Locomotives

Type	Mikado 2–8–2	Mallet 2–8–8–2	Electric 6–8–8–6
Wt. per driving axle	60,000 lb.	60,000 lb.	60,000 lb.
No. driving axles	4	8	12
Total wt. on drivers	240,000 lb.	480,000 lb.	720,000 lb.
Total wt. loco. and tender	480,000 lb.	800,000 lb.	780,000 lb.
Tract. eff. at 18 per cent coeff.	43,200 lb.	86,400 lb.	129,600 lb.
Gross tons 2 per cent grade	940	1,880	2,820
Trailing tons 2 per cent grade	693	1,495	2,430
Speed on 2 per cent grade	14 m.p.h.	9 m.p.h.	16 m.p.h.
Hp. at driver rims	1,620	2,080	5,570
I.hp. at 80 per cent eff.	2,030	2,600	...
Trailing tons-miles per hr. on 2 per cent gradient	9,700	13,500	38,800

The above analysis brings out the fact that to equal the hourly ton-mile performance of one electric locomotive it would require three and four engine crews, respectively, for the Mallet and Mikado types. Furthermore, the electric performance as tabulated above can be obtained with each individual locomotive practically regardless of climatic conditions, efficiency of the crew or time that has elapsed since shopping; and with a demonstrated reliability that has set a new standard in railroading.

Mountain Service

The electric locomotive has demonstrated its very great advantages in relieving congestion on single-track mountain-grade divisions. The number of meeting points on a single-track line increases as the square of the number of trains operating at one time and is proportional to the average speed, so it will be appreciated what an advance in mountain railroading is opened up by the adoption of the electric locomotive.

The hazard of mountain operation is greatest on down grades, although the perfection of automatic air brakes has done much to modify its dangers. It is left to electricity, however, to add the completing touch to the safe control of descending trains by supplying regenerative electric braking. Not only are air brakes entirely relieved and held in reserve by this device, but the potential energy in the descending train is actually converted into electricity which is transmitted through the trolley to the aid of the nearest train demanding power. Aside from the power returned from this source (14 per cent of the total on the Chicago, Milwaukee and St. Paul Railway), the chief advantage of electric braking lies in its assurance of greater safety and higher speeds permitted on down grades. The heat now wasted in raising brake shoes and wheel rims often to a red heat is returned to the trolley system and becomes an asset instead of a likely cause of derailment.

Cost of Maintenance

In order to draw a fair comparison, there should be added to the maintenance charges for locomotives the cost of back shop repairs and all expenses of roundhouse, turntable, ashpit, coal and water stations—in fact the many items contributing to rendering necessary steam-engine service, as most of these charges are eliminated by the adoption of the electric locomotive. Spare parts can be substituted so quickly that, excepting in cases of wreck, there is no need of the back shop, for electric locomotives, unless turning tires and painting may be considered heavy repairs. Electric locomotives are now being operated 3000 miles between inspections on at least two electrified railways and the following figures are available:

Electric-Locomotive Maintenance, Year 1919

	N. Y. C.	C. M. & St. P.	B. A. & P.
Number locomotives owned	73	45	28
Locomotive weight—tons	118	290	84
Annual mileage	1,946,879	2,321,148	566,977
Repairs per mile	6.39 cents	14.65 cents	6.48 cents

On the basis of prewar prices, maintenance costs were approximately 60 per cent of above figures given for the year 1919. In contrast, it can be stated that the present cost of maintaining a type 2–8–8–2 Mallet is fully 60 cents per engine-mile, without including many miscellaneous charges not shared by the electric locomotive. Possibly more direct comparison may be better drawn by expressing maintenance in terms of driver weight.

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[1] Chairman, Electrification Committee, General Electric Company.

Steam and Electric Repairs

	Steam Mallet	C. M. & St. P. Electric
Cost repairs per mile	60 cents	14.65 cents
Weight on drivers	240 tons	225 tons
Cost repairs per 100 tons locomotive weight on drivers	25 cents	6.52 cents

Including all engine service charges, the facts available give foundation for the claim that electric locomotives of the largest type can be maintained for from 25 to 30 per cent of the upkeep cost of steam engines operating in similar service.

Fuel Saving

Fuel economy figured prominently among the several reasons leading up to the replacement of the steam engine on the Chicago, Milwaukee and St. Paul Railway as brought out by a careful analysis of the performance of the steam engines then in service.

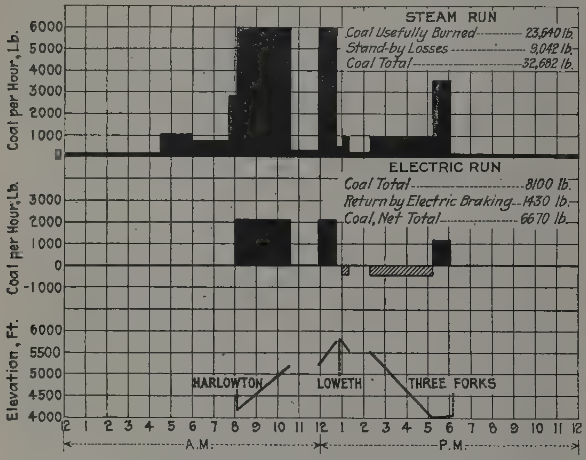

Fig. 1 Coal Record for Steam and Electric Runs from Harlowton to Three Forks, 1000 Gross Tons Moved

Although the steam engines tested may now perhaps be considered obsolete and not within the scope of this discussion of the modern engine, nevertheless it is not without value to compare the results of steam and electric locomotives operating over such long distances under identical conditions. The following data as given in Fig. 1 are therefore submitted as applying to a particular equipment only. No claim is made that they are representative of the best modern steam-engine performance, although many thousands of steam engines still in operation will show no greater economies than those given in the following table. The general data applying to the steam and electric locomotives tested are as follows:

C. M. & St. P. Locomotive Test Data

Type	Steam 2–6–2	Electric 4–4–4–4–4–4
Weight of engine	206,000 lb.	568,000 lb.
Weight of tender	154,000 lb.	...
Weight total engine and tender	360,000 lb.	568,000 lb.
Weight on drivers	152,000 lb.	450,000 lb.
Ratio driver weight to total	42.2 per cent	79.3 per cent
Rigid wheelbase	13 ft.	10 ft. 6 in.
Diameter drivers	63 in.	52 in.
Cylinders	21 in. × 28 in.	...
Boiler pressure	200 lb.	...
Heating surface	2346 sq. ft.	...
Grate area	45 sq. ft.	...
Water capacity	8000 gal.	...
Coal capacity	14 tons	...

Other engines were also tested over other sections of track, but the particular runs recorded in Fig. 1 were chosen for illustration as bringing out most strikingly the inherent disadvantages of operating a steam engine over a single-track mountain-grade division and handicapped by the usual delays attending freight-train service under such conditions. The run of 111.1 miles from Harlowton, elevation 4162 ft., to Three Forks, elevation 4066 ft., over the Belt Mountain Divide at Loweth, elevation 5789 ft., was made by steam with 871 tons trailing in 26 cars and by electric locomotive hauling 64 cars weighing 2762 tons. In order to picture a direct comparison of the results of the steam and electric runs, test data are reduced to a common basis of 1000 gross tons moved, this unit of measurement including the locomotive and tender weight. The running speed of the electric train was but slightly higher than the steam and the additional correction in the power demand rate of the former is made proportional to the lower speed. Both runs are therefore shown as made in identical time on the basis of 1000 total gross tons moved in each instance. The fuel furnishing power to the steam train was coal having the following analysis:

Coal Analysis

Fixed Carbon	Volatile Carbon	Ash	Moisture	B.T.U's.
47.99	38.98	8.35	4.68	11,793

Electric power was furnished by water and hence no direct coal equivalent is provided by the test result. To afford a common basis of comparison, however, a single assumption seems permissible and a rate of $2^1/_2$ lb. of coal per kilowatt-hour is taken as representative of fair electric power-station practice. Power input to the electric locomotive was obtained by carefully calibrated recording wattmeters as well as curve-drawing volt and ampere meters. These values of locomotive input were raised to the value of three-phase power purchased in the ratio of 68 per cent (given by R. Beeuwkes in his A.I.E.E. Paper of July 21, 1920), and the kilowatt-hours so obtained reduced to coal equivalent in the ratio of $2^1/_2$ lb. coal per kw-hr.

The run of a more modern steam engine would have effected a material reduction in the 23,640 lb. of coal burned in doing useful work, but the amount of coal wasted in stand-by losses (9042 lb.) might have been duplicated or even possibly increased with larger grate area. As standby losses constitute so large a proportion of the coal total burned ($27^1/_2$ per cent in this instance) it is apparent that enormous economies over the simple engine tested must be realized in the modern superheater and other improvements since introduced to offset in part the high inherent efficiency of the electric locomotive.

[In his complete paper the author gives a further analysis of the foregoing test in which he deduces comparative figures for coal per hp-hr. at driver rims and total coal per rim hp-hr., showing still more favorably for the electric locomotive. He estimates that whatever transmission and conversion losses are interposed between power house and electric locomotive are more than compensated for by the improvement in load factor resulting from averaging the fluctuating demands of many individual locomotives. —Editor.]

It would be a simple matter to carry through a series of runs over the electrified zone of the C. M. & St. P. with a modern Mikado equipped with all the up-to-the-minute fuel-saving devices and thus provide the necessary data to draw direct comparisons with the electric locomotive. Such tests with modern steam equipment would undoubtedly discredit the above comparison based upon the economies of six years ago and might lead to something approximating the following blend of fact and theory:

Theoretical Comparison of Modern Steam and Electric Locomotives
Harlowton—Three Forks

Type	Mikado 2–8–2	Electric 4–4–4–4–4–4
Weight on drivers	240,000 lb.	450,000 lb.
Weight engine and tender	480,000 lb.	568,000 lb.
Tractive efficiency, 18 per cent coefficient	43,200 lb.	81,000 lb.
Trailing ton 1 per cent grade	1,420	2,836
Hp-hr. at driver rims	4,360	8,200
Coal per i.hp-hr	3	...
Coal per driver hp-hr	3.75	...
Stand-by loss—test result	9,042 lb.	...
Stand-by loss per hp-hr	2.15 lb.	...
Total coal per driver hp-hr	5.90 lb.	...
Coal at power house kw-hr	...	2.5 lb.
Coal at power house hp-hr	...	1.86 lb.
Coal at locomotive driver hp-hr	...	3.09 lb.
Coal credit due regeneration	...	0.55 lb.
Net coal at driver hp-hr	5.90 lb.	2.54 lb.
Total net coal	24,800 lb.	20,900 lb.
1000 trailing ton-miles	157,500	314,000
Coal per 1000 ton-miles	158 lb.	66.7 lb.
Ratio coal burned	2.37	1

The above table is based upon actual electric-locomotive performance, Harlowton—Three Forks, coal taken at $2^1/_2$ lb. per kw-hr. at assumed steam power station. Steam-engine values are based upon the known working efficiency of a Mikado equipped with superheaters, but penalized with the same stand-by losses actually determined with simple engine tested on the Harlowton—

Three Forks run. A test run from Harlowton to Three Forks with a modern Mikado engine hauling 1420 tons may possibly show a lower average fuel rate than 3 lb. per i.hp-hr. at drivers, less stand-by waste than 9042 lb. coal, but the average annual performance of many such engines would be most excellent if it reached the net figure arrived at of 5.9 lb. coal per actual hp-hr. work performed at drivers. The electric run, however, is being duplicated daily, as to relation between kilowatt-hours and ton-miles, and it is just this reliability of electric operation that may at times give rise to misunderstanding in the comparison of steam and electric data.

Each individual electric locomotive will reproduce almost exactly the record of all others in similar service, little influenced by either extreme cold or skill of the engineer, while the fireman so-called and still retained, has nothing to do with the matter at all. There is no creeping paralysis gradually impairing the efficiency of an electric locomotive until temporary relief is obtained through frequent boiler washings and roundhouse tinkering, inevitably ending up in the major operations annually performed on the steam engine in the back-shop hospital to keep it going. It is for such reasons that the electrical engineer is slow to accept general statements of average service operation based on the results of tests usually made on steam engines in excellent condition and skillfully handled.

It is with some knowledge of all these facts that the broad statement is made that the general adoption of the electric locomotive would probably result in saving fully two-thirds the fuel now burned on present steam engines and possibly one-half the amount of fuel necessary to steam engines of the most modern construction.

Comparative Cost

The superior operating advantages of the electric locomotive are admitted by many who believe the first cost to be prohibitive, largely due to the trolley construction, copper feeders, substations, transmission lines, etc., necessary to complete the electrification picture. It is true that such auxiliaries add an amount that may equal the electric-locomotive expense and the task of proving the electric case is not made easier by the fact that steam-engine facilities are already installed and may have little or no salvage value to offset new capital charge for electrification.

Comparing the cost of equivalent steam and electric motive power, it is apparent that on the basis of the same unit prices for labor and material, the first cost is approximately the same. While electric locomotives cost possibly 50 per cent more than steam for equal driver weight, the smaller number required to haul equal tonnage may quite offset this handicap, especially with quantity production of electric locomotives of standard design.

The steam engine also demands a formidable array of facilities peculiar to itself as shown by expenditures made on fourteen railways included in the northwestern group from 1907 to 1919, in which the expense for engines was $68,000,000 and for water stations, shops, enginehouses, shop machinery, turntables, ash-pits, etc., was $42,000,000.

DISCUSSION

H. B. Oatley[1] suggested that the respective merits of steam and electric locomotives should be considered from the point of view of the return on the capital investment. Modern types of both steam and electric locomotives, he said, must be compared with each other, and the losses in the operation of the one compared with similar losses in the operation of the other. Mr. Oatley expressed his confident belief that the improvements in the steam locomotive, many of which are past the experimental stage and are beginning to be applied as part of regulation equipment, would result in making the steam locomotive so much better, from a fuel and efficiency standpoint, that combined with the other points of advantage which it possesses it would be enabled to retain its superiority.

F. J. Cole[2] called attention to the slow progress which has been made in the United States toward superseding the steam locomotive. Records showed that in April 1919 there were 675 electric locomotives operating in the country. It seems, therefore, that in the 27 years since the building of the first electric locomotive only one per cent of the steam locomotives have been superseded by electric locomotives. Mr. Cole insisted that the relative merits of steam and electric locomotives must be determined largely on the basis of cost. He said that the reports of electrifications do not give costs of installation. The questions that should be answered are: Is it cheaper to operate by steam or by electricity, and can freight per ton-mile be moved at less cost, when all expenditures are considered, by electricity than by steam?

C. H. Quinn[1] presented comparative figures of fuel consumption on the electrified division of the Norfolk & Western Railroad and on modern Mallet engines under similar operating conditions. The figures showed a fuel saving of 29.3 per cent in favor of electric operation.

A. L. Ralston[2] gave data on the thermal efficiency of the 3000-volt direct-current system. On the electrified section of the New York, New Haven and Hartford Railroad the efficiency at full load is 8 per cent; at 75 per cent load, 7.8 per cent; and at 50 per cent, 7.4 per cent. In passenger service, 9.3 lb. of coal are consumed per car-mile on the electrified section, and 19.3 lb. per car-mile on the steam-operated section. The net saving through electrification is thus $393,000 a year, assuming coal to cost $5 a ton. In freight service, electric locomotives consume 84 lb. of coal per 1000 gross ton-miles, while steam locomotives average 199 lb. per 1000 gross ton-miles, the saving being $268,000 a year. The corresponding figures in switching service are 38.3 for electric and 106.8 for steam locomotives, and the saving in this service $94,000. The electrification therefore effects an annual gross saving in the cost of fuel amounting to $755,000.

F. H. Hardin[3] said that the maintenance costs of New York Central Mallet locomotives, including shop and enginehouse repairs, were from 24 to 37 cents per mile, as against the estimate of 60 cents offered by Mr. Armstrong. Also that Mr. Armstrong's estimate of 158 lb. of coal consumption per 1000 gross ton-miles for Mikado locomotives is disproved by the records of locomotives of this type operated by the New York Central Railroad, which have shown a coal consumption of 125 to 130 lb. per 1000 gross ton-miles.

W. L. Bean[4] summed up the comparative advantages and disadvantages of both steam and electric locomotives. Electrical operation requires less coal per unit of traffic handled than steam operation. The mileage per unit of electric equipment is ordinarily greater per unit of time. The first cost of electric locomotives per unit of capacity is greater than in the case of steam. Large electric locomotives cannot be used for heavy local service because of the heating caused by frequent starting. In such service the maximum train which can be handled by an electric locomotive can only approximate what can be handled by a steam engine of about 30,000 lb. tractive effort. As regards design, the discusser contrasted the steady development of the steam locomotive along lines of possible common usage and practice with the vast field of opinion among electrical engineers as to types of installation. He hoped that the lines of development of electrical facilities would tend to converge rather than diverge too widely.

In conclusion, Mr. Bean said that study and comparison of the details, item for item, of any large activity, is necessary in order to get the benefit of real analysis, but satisfactory conclusions as to the merits of the entire project cannot be reached by setting up in a partisan way outstanding advantages on the one hand any more than by listing all the disadvantages on the other. Certain more or less intangibles are important and must be weighed impartially. Among such are the increase in real-estate value through electrification, increased capacity of road, comparative safety and reliability of operation, permanence of type of design, obsolescence and depreciation factors, etc. Tangibles from a money standpoint can and should be segregated and set up in full scope on both sides of the case and conclusions based on the net result at the bottom line of the balance sheet. If fixed charges on plant, including equipment, plus maintenance charges, plus other outgo, outweigh the savings in fuel plus other operating savings, the net result is a deficit and all manner of proclaiming isolated pecuniary advantages would not induce a careful investor to support the enterprise.

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[2] Mechanical Superintendent, N. Y., N. H. & H. R.R.

[3] Chief Engineer of Motive Power, N. Y. Central R.R.

[4] Asst. Mechanical Superintendent, N. Y., N. H. & H. R.R., New Haven, Conn. Mem.Am.Soc.M.E.

R. Beeuwkes[1] dissented from the statements made by Mr. Muhlfeld in regard to the electrification of the Chicago, Milwaukee and St. Paul Railway. The Virginian steam articulated locomotive, he stated, could not justifiably be compared with the St. Paul electric articulated, as each was designed for an entirely different service and operated under entirely different conditions. The St. Paul locomotive was designed to provide capacity sufficient to handle a 2500-ton trailing load over any portion of the profile without helper on grades of one per cent or less, at a speed of approximately 16 miles per hour. It was not built with the idea of securing the maximum capacity possible, as it appeared to Mr. Bean that Mr. Muhlfeld had implied. In addition, Mr. Bean insisted that fuel economy is not the most important claim for electrification. He referred to decreased cost of engine repairs, enginehouse expenses, train and enginemen wages and increased ton-mile capacity of the electric locomotive as of more importance. Other advantageous features he mentioned were ability to carry overloads and ease of starting trains.

W. F. Kiesel,[2] Jr. submitted experimental data to show that electric operation does not save coal. He said that with the exception of capital investment, coal per drawbar horsepower and stand-by losses, there is too little difference between the two types for operation in open country to warrant further consideration. He also said that, for either steam or electric operation, the length of divisions and locations of terminals are governed by other than locomotive limitations.

E. B. Katte[3] produced a table which showed that fuel-consumption data are apt to be misleading in so far as comparisons are concerned, due to widely different conditions on the various roads in question. He cautioned against placing too much reliance on results obtained from test runs, notwithstanding the fact that they fairly simulate actual conditions. He advised that instead, service records extending over several years should be used, and the data carefully collected, correlated and averaged to give results that may be expected in everyday operation.

George Gibbs[4] contrasted the two kinds of power plants for conducting railway transportation from the standpoints of both design and performance. In steam service, he said, the plant is a part of the moving train; in electric it has both stationary and moving elements, viz., a central power-generating plant, various connecting links to bring the power to the train, and means of utilizing it there. As regards simplicity, therefore, the self-contained steam locomotive has an inherent advantage over the combination of elements required for electric propulsion, and the latter must show some peculiar advantages in an *operating*, rather than a *structural*, sense if it is to supersede steam traction. Furthermore, the steam locomotive has been developed to a perfection of detail and a high degree of steam accuracy during the one hundred years of its use; it does wonderful work and is in possession of the field representing a heavy money investment, and therefore can only be displaced, even by something better, by slow degrees. He contended that electrical as well as mechanical engineers must, in the light of evidence furnished by existing installations, concede than an electric system will function in a successful, reliable and efficient manner for any kind of railway service. It is capable of unlimited hauling capacity, is flexible as to speed and has important features conducing to safety in handling trains. But in his opinion the fundamental question affecting the adoption of electric locomotive is whether or not its substitution for steam is warranted by its advantages in the production of more transportation, and if so, whether this is practicable financially. It will be found, he said, that electric traction will pay, directly or indirectly, in special cases to an extent depending upon the density of traffic and the difficulty of maintaining proper steam operation. As it is unquestionable that an electric installation involves a higher first cost than for steam, its adoption means that more or less existing investment must be scrapped, and therefore the increase in fixed charges must be offset either by the direct operating savings produced or these plus the indirect savings and benefits. The final conclusion arrived at by Mr. Gibbs was that there is always a large saving in fuel with electric traction, generally some saving in maintenance cost of power equipment and often important savings in train-crew costs, enginehouse expenses and minor supplies.

A. W. Gibbs[1] submitted data for a 2–10–0 type steam locomotive of which over 100 are in regular service, which he stated, represent better practice than the locomotives referred to by Mr. Armstrong in the second table of his paper. He said that these locomotives were expressly designed to do all of their work within the economical range of steam distribution, the required power being obtained by increases in steam pressure and size of cylinders. While he had given the power at nearly the speed mentioned by Mr. Armstrong, the performance was excellent at double the speeds given, but the sacrifice in drawbar pull—from nearly 60,000 lb. at 14.7 m.p.h. to about 43,000 lb. at 25.3 m.p.h.—would not be justified. In brief, the improvements in the steam locomotive, if properly availed of, have much narrowed the field of economical electrification.

DATA ON 2–10–0-TYPE STEAM LOCOMOTIVE

Weight in Working Order	371,000 lb.
Weight on Drivers	342,050 lb.
Weight on Engine and Tender	523,000 lb.
Tractive Effort at 14.7 miles per hour, 45 per cent cut-off	58,900 lb.
Gross Tons (2 per cent grade)	1,280
Trailing Tons	1,019
Coal per D.H.P. at this speed and cut-off	2.8
Tractive Effort at 22 miles per hour, 40 per cent cut-off	42,500 lb.
Gross Tons	923
Trailing Tons	662
Coal per D.H.P	3.2
Tractive Effort at 25.4 miles per hour, 45 per cent cut-off	43,600 lb.
Gross Tons	948
Trailing Tons	687
Coal per D.H.P	3.8

The same arrangement of limited maximum cut-off used in the 2–10–0 locomotive has been embodied in a simple Mallet now running which has the same speed elasticity as the 2–10–0 type.

Stand-by Losses. While these losses are actual and large it is very difficult to fix their value. The electric locomotive has the advantage provided there are sufficient trains in motion to smooth out the total demand on the power plant.

Weather. The independence of the electric locomotive in severe weather is another undoubted advantage, not so much because of the performance of the motors as from the avoidance of losses and delays due to ashpit work and to frozen pipes and other parts, incidental to the presence of water on the steam locomotive.

Liability to Interruption. Electric operation is dependent on uninterrupted connection with the source of power. In the event of breakage of the line, especially of the overhead construction, the trains in the section involved are dead and cannot get themselves out of the way of the repair trains.

Speeds. The question of speed has evidently been treated from the freight standpoint, for there has never been any question as to the speed capacity of well-designed passenger locomotives, being far beyond that permitted by the rules. As he saw it, the high-speed of trains was less important than uniformity of speeds of different trains. If tonnage trains had the same speed as preference trains, and could thus avoid the great delay due to side tracking of trains of inferior rights, far more would be accomplished than the mere saving in time over the division due to the increased speed.

In the maintenance cost per mile of different electric locomotives, given by Mr. Armstrong, it should be said that any figures of post-war dates are so clouded by the abnormal labor and material costs as to be very doubtful. These locomotives have not run long enough to reach a general level of costs and it would be noted that the average annual mileage is low except in the case of the Milwaukee locomotive. Besides this, there is no evidence as to the maintenance costs of the rest of the outfit, including power plant, transformers, transmission lines, converters or transformers, trolley or third-rail and track circuits, all of which are essential

(*Continued on page 726*)

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SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

SUBJECTS OF THIS MONTH'S ABSTRACTS

- Water Turbines, New Analytical Theory
- Water Turbines, Method of Design
- Rateau-Battu-Smoot High-Speed Blower
- Copper Steel
- Oil-Fired Boiler Economies
- Centrifugal Pumps, Drop in Output after Starting
- Blast-Furnace Gas Cleaner
- War-Vessel Design
- Submarines in Naval Warfare
- Aircraft in Naval Warfare
- Ground Vibrations, Transmission to a Distance
- Ground Vibrations, Damping
- Steam Control Device, Low-Pressure Turbines, Steam Control Device
- Water-Indicating Devices, Tests
- Locomotives, Tests of Water-Indicating Devices
- Carey Oil Transmission System
- Regan Automatic Train-Control System
- British Committee for Scientific and Industrial Research
- Zirconium Steels
- Fuel Research in England
- National Institute of Research for Canada
- Steam Nozzles
- Steam Diffusors
- Magnetic Testing Apparatus
- Defectoscope
- Truck Transportation in the Steel Industry

New Analytical Theory of Water Turbines

New Analytical Theory of Water Turbines, Prof. A. Petot. Analytically, the problem therefore resolves itself to a search for the maximum value of a function of two independent variables such that their variation occurs within fairly well-restricted intervals. By selecting these variables in a convenient way all the elements of a turbine can be expressed as functions of an auxiliary unknown value given by an equation of the second degree with numerical coefficients. The author proceeds in the following manner.

As a rule in the analytical theory of water turbines it is customary to neglect losses of energy due to viscosity, friction and shocks. It is here shown how these may be accounted for with sufficient approximation and without running into excessive complications. Let H be the head of the water fall; v, u, w the absolute velocity, the velocity of entrainment and the relative velocity at the entrance to the wheel; α the angle of v with u and β the angle of w with v, continuation of u; v_1, u_1, w_1, α_1 and β_1 are the same elements for the exit from the wheel; r and r_1 are the average radii and m is the ratio r_1/r; $kv^2/2g$ and $k'w^2/2g$ the losses which have to be taken care of; ϵ is the degree of reaction of the turbine and ρ is its internal efficiency.

If one neglects certain magnitudes which are given in the problem and others such as the angles α and β_1 which must be as small as possible, the efficiency ρ is merely a function of two variables and it is obvious that these variables should be selected in such a manner that the calculation may be carried through without neglecting any important terms. As a result of his investigations the author has been led to select as such variables v and u.

The first question with which one has to deal in a calculation carried on in the manner indicated is that of expressing w_1, v_1 and ρ as functions of v and u. From the two basic equations

$$\rho g H = uv \cos \alpha - u_1 v_1 \cos \alpha_1 \ldots\ldots\ldots\ldots [1]$$

$$\rho = 1 - \frac{v_1^2}{2gH} - k\,\frac{v^2}{2gH} - k'\,\frac{w_1^2}{2gH} \ldots\ldots\ldots\ldots [2]$$

it is found that

$$gH - \frac{v_1^2}{2} - k\,\frac{v^2}{2} - k'\,\frac{w_1^2}{2} = uv \cos \alpha - u_1 v_1 \cos \alpha_1 \ldots [2a]$$

Equation [2a], after obvious transformations, becomes

$$(1 + k')\, w_1^2 = 2gH + m^2u^2 - 2uv \cos \alpha - kv^2 \ldots\ldots [3]$$

From a consideration of the triangle at the exit, the author obtains

$$v_1^2 = m^2u^2 + w_1^2 - 2muw_1 \cos \beta_1 \ldots\ldots\ldots\ldots [4]$$

and finally from Equations [4] and [2].

$$\rho g H = uv \cos \alpha + muw_1 \cos \beta_1 - m^2u^2 \ldots\ldots\ldots [5]$$

The desired equation is thus obtained without neglecting any terms. However, in order not to complicate the computations too much it is advisable to preserve for the time being w_1 as an auxiliary variable, bearing in mind, however, that in due time it can be gotten rid of by means of Equation [3].

Determination of the Optima Values of v and u

The two partial derivatives $\frac{\partial \rho}{\partial u}$ and $\frac{\partial \rho}{\partial v}$ of ρ must be reduced to zero value, which involves the use of Equation [5] and also of w_1. These latter may be deduced from Equation [3], which gives

$$\left.\begin{aligned} (1 + k')w_1 \frac{\partial w_1}{\partial u} &= m^2u - v \cos \alpha \\ (1 + k')w_1 \frac{\partial w_1}{\partial v} &= - u \cos \alpha - kv \end{aligned}\right\} \ldots\ldots\ldots\ldots (a)$$

Now, equating in succession to zero the expressions $\frac{\partial \beta}{\partial u}$ and $\frac{\partial \rho}{\partial v}$ there are obtained from these two equations

$$\left.\begin{aligned} (1 + k')w_1 (v \cos \alpha - 2m^2u) + m \cos \beta_1 (2gH + \\ 2m^2u^2 - 3\,uv \cos \alpha - kv^2) = 0 \\ (1 + k')\, w_1 \cos \alpha - m \cos \beta_1 (u \cos \alpha + kv) = 0 \end{aligned}\right\} \ldots (b)$$

which together with Equation [3] determine the optima values of u and v, and also the corresponding value of w_1. If in the first of these two equations w_1 be replaced by its value

$$w_1 = \frac{m \cos \beta_1}{(1 + k') \cos \alpha}\,(u \cos \alpha + kv) \ldots\ldots\ldots\ldots [6]$$

from the second equation there results an equation of state

$$uv \left(\cos \alpha + \frac{m^2k}{\cos \alpha} \right) = gH \ldots\ldots\ldots\ldots\ldots [7]$$

which differs but little from the equation given by Poncelet.

Proceeding now in the same manner, from Equations [6] and [7] we obtain

$$m^2u^2 \cos^2 \alpha\, (k' + \sin^2 \beta_1 - kv^2[m^2k \cos^2 \beta_1 + (1 + k') \cos^2 \alpha] \\ + \frac{2m^2kgH \cos^2 \alpha(k' + \sin^2 \beta_1)}{\cos^2 \alpha + m^2k} = 0 \ldots\ldots\ldots\ldots [8]$$

which thus provides a system of two quadratic equations for determining the two principal unknown values v and u.

On the other hand, in order to verify a priori Equation [7], the author places

$$v^2 = \frac{gH \cos \alpha}{\cos^2 \alpha + m^2k} \times x \ldots\ldots\ldots\ldots\ldots [9]$$

and

$$u^2 = \frac{gH \cos \alpha}{\cos^2 \alpha + m^2k} \times \frac{1}{x} \ldots\ldots\ldots\ldots\ldots [10]$$

in which x designates the auxiliary unknown quantity equal to $\frac{v}{u}$. If these values of v^2 and u^2 are inserted in Equation [8], then

$$x^2\left(k \cos^2 \beta_1 + \frac{1 + k'}{m^2} \cos^2 \alpha \right) - 2x \cos \alpha\, (k' + \sin^2 \beta_1) \\ - \cos^2 \alpha\, \frac{k' + \sin^2 \beta_1}{k} = 0 \ldots\ldots\ldots\ldots\ldots [11]$$

which is of quadratic character and has numerical coefficients.

It has also real roots with opposite signs and it is evident that the positive root x' is the only one that suits the case. From this we can pass to v and u, and all the rest can be deduced, as will be shown by comparatively simple numerical computations which can be carried out with such approximation as may be desired.

CALCULATION OF THE OTHER ELEMENTS OF THE TURBINE

The degree of reaction ϵ is given by the usual formula

$$1 - \epsilon = \frac{(1+k)v^2}{2gH} \ldots\ldots\ldots\ldots [12]$$

or else by

$$1 - \epsilon = \frac{(1+k)x' \cos \alpha}{2\,(\cos^2 \alpha + m^2 k)} \ldots\ldots\ldots [12 \text{ bis}]$$

which can be directly deduced therefrom. In order that the value of ϵ be positive it is necessary that

$$\frac{(1+k)x' \cos \alpha}{2\,(\cos^2 \alpha + m^2 k)} < 1 \ldots\ldots\ldots\ldots [c]$$

or else

$$x' < \frac{2(\cos^2 \alpha + m^2 k)}{(1+k) \cos \alpha} \ldots\ldots\ldots\ldots [13]$$

For this it is necessary that when x is the first member in Equation [11] to be replaced, the result obtained should be positive. Hence, there must be between the elements α, β_1, m, k and k' a characteristic inequality of operation with reaction. The author does not attempt to give this inequality explicitly as it is quite complex, but he shows that with the usual value of the elements above referred to it is present.

The angle β is deduced as usual from the formula

$$\frac{v}{u} = \frac{\sin \beta}{\sin (\alpha + \beta)} \ldots\ldots\ldots\ldots [14]$$

which, bearing in mind the values of v and u, gives

$$\tan \beta = \frac{x' \sin \alpha}{1 - x' \cos \alpha} \ldots\ldots\ldots\ldots [15]$$

In order to determine the relative velocity w at the entrance to the wheel, we have the relation

$$w^2 = u^2 + v^2 - 2\, uv \cos \alpha \ldots\ldots\ldots\ldots [16]$$

which may be applied under the above form or replaced by

$$w^2 = \frac{gH \cos \alpha}{\cos^2 \alpha + m^2 k} \left(x' + \frac{1}{x'} - 2 \cos \alpha \right) \ldots [16 \text{ bis}]$$

where only the auxiliary unknown quantity x' is used.

As regards the exit velocity w_1, it is given by Equation [6], which requires, however, the preliminary computation of v and u by means of Equations [9] and [10]; Equation [3] might also be used in the same manner. From this, we pass to the ratio w_1/w, which must be taken into consideration in order to satisfy the conditions of continuity and to obtain the desired degree of reaction.

With w_1 known, one might also compute v_1 by means of Equation [4] and then the angle α_1 by considering the triangle of velocities at the exit. These two elements, however, are not used in the course of this investigation and, therefore, are merely mentioned for the sake of completeness. The former may have to be determined, if it should be desirable to know how the total loss of efficiency is distributed between the three negative members of Equation [2] and angle α_1, to compare its actual value with the values which have been attributed to it in accordance with the investigations of Euler and Poncelet and which are usually accepted today.

It is now necessary to determine only the internal hydraulic efficiency ρ which is obtained by means of Equation [5], where, however, v' is replaced by its value given by Equation [6] and also uv by their values obtained from Equation [7]. This gives

$$\rho = 1 - \frac{m^2(k' + \sin^2 \beta_1)}{1 + k'} \left(\frac{u^2}{gH} + \frac{k}{\cos^2 \alpha + m^2 k} \right) \ldots [17]$$

where for u^2 may be substituted its value from Equation [10], which gives

$$\rho = 1 - \frac{m^2(k' + \sin^2 \beta_1) \left(\frac{1}{x^1} \cos \alpha + k \right)}{(1 + k')(\cos^2 \alpha + m^2 k)} \ldots [17 \text{ bis}]$$

When the characteristic inequality has been verified, it is necessary to adopt operation with reaction in order to secure maximum efficiency, but the degree of reaction cannot be selected arbitrarily as it is fixed by Equation [12] and varies with the type of turbine. If the inequality is reduced to equality, we have a limit turbine with a zero reaction and a maximum efficiency. Should the inequality be reversed, the maximum efficiency proper to a turbine of that type could be obtained only by making the reaction negative, a case which the author does not consider at all.

Moreover, practice has shown that reaction turbines have as a rule the best efficiency, and it is likely that the characteristic inequality will be found correct in the majority of cases. This should be checked every time, however, by using Equation [13].

Furthermore, if we should admit that the coefficients k and k' both preserve the same values for all the turbines of a given type, which is likely to be true, we shall see that the idea of proportionality of turbines is presented here in as simple a manner as in the usual approximate theory. This makes it possible for us to dispense with the consideration of questions relative to the output q of the waterfall and the corresponding dimensions of turbines, as they can be considered in the same manner as is usually done.

APPROXIMATE FORMULÆ

Since the values of k and k' do not exceed 0.1, it is evident that in solving Equation [1] in the first approximation one may neglect entirely the term containing x and reduce the coefficient of x^2 to its second term. This gives for x' the comparatively simple approximate value

$$\xi = m \sqrt{\frac{k' + \sin^2 \beta_1}{k(1 + k')}} \ldots\ldots\ldots\ldots [18]$$

from which can be derived expressions for all the elements of the turbine. For example, with the same degree of approximation one may derive the following expressions:

$$v^2 = \frac{mgH}{\cos \alpha} \sqrt{\frac{k' + \sin^2 \beta_1}{k(1 + k')}} \ldots\ldots\ldots\ldots [19]$$

$$u^2 = \frac{gH}{m \cos \alpha} \sqrt{\frac{k(1 + k')}{k' + \sin^2 \beta_1}} \ldots\ldots\ldots\ldots [20]$$

$$1 - \epsilon = \frac{m(1 + k)}{2 \cos \alpha} \sqrt{\frac{k' + \sin^2 \beta_1}{k(1 + k')}} \ldots\ldots\ldots [21]$$

$$\rho = 1 - \frac{m}{\cos \alpha} \sqrt{\frac{k(k' + \sin^2 \beta_1}{1 + k'}} \ldots\ldots\ldots [22]$$

If necessary, the values of β, w, w_1, v_1 and α_1 may be obtained in the same manner.

If we say that ϵ as obtained from Equation [21] has a positive value, the characteristic inequality will be expressed as

$$\frac{k' + \sin^2 \beta_1}{1 + k'} < \frac{4k \cos^2 \alpha}{m^2(1 + k)^2} \ldots\ldots\ldots\ldots [23]$$

which is obviously only an approximation. It appears, however, in view of the factor $4/m^2$ that it must always be fairly well satisfied in the case of centripetal turbines and even in parallel turbines. There is doubt only in reference to centrifugal turbines. This explains why, as has been said above, there is always an advantage in having operation with reaction. These various approximate formulæ cannot take the place of the preceding precise formulæ in the calculation of the elements of turbine design, but they make it possible to view along broad lines the general operation and to give the first idea of the numerical values of certain of the elements which enter therein.

Thus, Equations [21] and [22] show first (because of the factor m, the variations of which have a more or less permanent influence than the variations of k and k') that the degree of reaction must be lower for parallel turbines than for centripetal turbines and that these latter have a better efficiency. From the equation

$$\rho = 1 - \frac{2k(1 - \epsilon)}{1 + k} \ldots\ldots\ldots\ldots [24]$$

which is a direct outcome of the preceding equations, it follows that the two properties of centripetal turbines, namely, the higher degree of reaction and better efficiency, are correlative with each other.

On the other hand, if we eliminate k' from between Equations [20] and [22], we obtain

$$k = \frac{(1-\rho)u^2 \cos^2 \alpha}{gH} \qquad [25]$$

which gives an approximate value of the coefficients k which will be utilized later on in this paper. The approximate value of k' might also be obtained in the same manner, but it does not appear to be of any use.

EXPERIMENTAL INVESTIGATION OF WATER TURBINES

First Series of Experiments. A good many experiments have been made on water turbines, but it would be difficult to deduce with any degree of precision for each particular type of turbine the average value of coefficients k and k' because the machinery on which the experiments were carried out was designed in accordance with old formulæ. Nevertheless, by properly interpreting the results of these experiments we can obtain for k and k' what might be called the first series of values, from which a start may be made to deduce other values more or less closely approaching the true values. To demonstrate how this is done, let us assume that we have a good reaction turbine M_0 and that its various elements have been determined as precisely as possible. Equations [10], [11] and [17] are then a system of three equations with three unknowns x, k and k', which may be solved in the following manner:

Let us assume that the unknown k has been given an approximate value from Equation [25] and that we designate this value by the letter a. Then we can immediately derive from Equations [10] and [17] corresponding values b and a' for the two other unknown quantities x and k; since, however, the value a of k' is only approximate, it is evident that Equation [11] cannot be verified by these numbers a, a' and b, and hence its first term will have a certain value n, different from zero. If, however, we repeat the same calculation by giving to k another value a_1 in the neighborhood of the value a, then numerical values a', b and n will be replaced by other values a_1 b_1 and n_1 lying in the neighborhood of the former values. It is obvious that the method of interpolation can be applied here, and it is easy to see how one can obtain, with as close approximation as may be desired, values x_0, k_0 and k_0' for the unknown quantities x, k and k' of the turbine M_0.

These two numbers k_0 and k_0' are the first couple of values of the coefficients k and k' and their approximation is the closer the better the turbine M_0 is designed. The degree of precision attained in this manner in the determination of the values of the coefficients may be established by comparing M_0 to a turbine M_0' designed in accordance with the formulæ given earlier in this article, where k and k' are taken to be respectively equal to k_0 and k_0'. In this connection one is led to consider simultaneously with the constructional elements β and $\lambda = w_1/w$ of the turbine M_0, also the corresponding elements β' and λ' of the turbine M_0' and to compare them with each other.

If it should be found that β' and λ' are equal to β and λ, respectively, that will mean that the turbine M_0' is nothing else but the turbine M_0 and that hence the desired values of k and k' are k_0 and k_0' exactly. The question will therefore be immediately solved for all machines of the same type as M_0 without there being any need of further experimentation. However, there is but little likelihood that this might be the case and all that one has the right to expect is that the differences $\beta' - \beta$ and $\lambda' - \lambda$ will be very small. In that case the conditions of maximum of efficiency would not be entirely satisfied in the turbine M_0 and one would be led to look forward to a turbine M_1 which, while being very close to M_0 would have a somewhat better efficiency. This is a problem clearly different from that which has been considered above and therefore new experiments would be necessary to solve it.

Second Series of Experiments. In the first place, in accordance with what has been stated above, it becomes necessary to give to k and k' numerical values somewhat lower than k_0 and k_0'. This is, however, only the first indication of what should be done and in order to progress it is necessary to proceed by a series of trial values. Let us imagine, for example, that by taking k and k' to be equal respectively to $0.98k_0$ and $0.98k_0'$ we obtain for ρ by means of Equations [11] and [17 bis] a value which appears to be acceptable. In that case it may be used provisionally; otherwise, the values of k and k' would have to be either decreased or increased slightly by methods of interpolation, the values of $\beta' - \beta$ and $\lambda' - \lambda$ being the guides as to whether the efficiency values should be accepted.

The new values of k and k', viz., k_1 and k_1', having been selected in the above-described manner, let us now imagine that we are computing all the elements of the turbine M_1 by means of the general equations given above, that we have built the machine and that we have set it in operation under the same conditions as the turbine M_0. Then as regards the maximum efficiency and the operating velocity the distinction should be made between two sets of values—first, ρ and u computed a priori from the Equations [17 bis] and [10] and the values ρ' and u' obtain experimentally by direct measurement. In fact, by comparing ρ with ρ' and u with u' we can see with what degree of approximation the values k_1 and k_1' approach the desired values of k and k'. The reasoning is here similar to that by means of which we have passed from the first experimental turbine M_0 to the second, M_1.

Let us assume at first that ρ' and u' are respectively equal to ρ and u. The conditions of maximum efficiency having been then satisfied in the turbine M_1 the desired values of k and k' are exactly k_1 and k_1' and the experiment is satisfactorily computed. In practice it is sufficient for the same purpose that the differences $\rho' - \rho$ and $u' - u$ should be very small, and it is likely that this might be the case if the turbine M_0 from which we have started has been well designed.

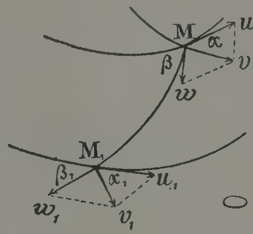

FIG. 1 DIAGRAM OF THE TURBINE CONSIDERED BY PROFESSOR PETOT

On the other hand, if these differences be quite large the experiments have to be continued. The author does not attempt, however, more than to indicate the direction of the experiments. As the turbine M_0 has been built in accordance with the general formula with values of k and k' lower than k_0 and k_0', it is likely that its effective efficiency ρ' will be somewhat higher than that of the turbine M_0. This is admitted by the author, with the reservation that should experiment show that this is not the case, the admission might be modified in the further experiments which would be easy because the same method would have to be followed.

Admitting, however, that the turbine M_1 represents from the point of view of efficiency a step forward as compared with the turbine M_0, the same manipulations are carried out with M_1 as were carried out with M_0 so as to secure a design for a third turbine M_2, which presumably would represent a step ahead as compared with M_1, and so on until a turbine is designed in which the differences between $\rho' - \rho$ and $u' - u$ are negligible, which may be considered as the end of the experiments. The important part of this process is that while more and more correct values are obtained for the coefficients k and k', the efficiency of the turbine of a given type is likewise improved.

CONCLUSIONS

In the study of water turbines, by taking for an auxiliary unknown quantity the ratio $x = v/u$ of the absolute velocity and velocity of flow at the entrance to the blades, one may carry to a final conclusion the computations of turbine design by taking into consideration all the charge losses, and without neglecting any of the terms. This unknown quantity x is given by a quadratic equation, which is not surprising, as the various methods, whether analytical or graphical, proposed for the investigation of turbine design (in particular, those of Bodmer and Rateau) come back in the final end to an approximate solution of an equation of this order.

Once, however, we have obtained the value of x for a given set of conditions, we can deduce from it by means of comparatively simple equations all the elements of construction and operation of a turbine of a given type. Also, by neglecting in the quadratic equation of x, certain terms which are very small as compared with other terms we are enabled to derive a series of approximate formulæ, which, while not capable of replacing the exact formulæ for the computations, involved in turbine design, still enable us to obtain a preliminary idea of their general operation.

All these considerations obviously would not amount to much if we were unable to determine with sufficient approximation the values which we must attribute for each type of turbine to the coefficients of loss k and k'. Ways are, however, described and given showing how this may be done in a practical manner.

The coefficients, k and k', by the way, are not true coefficients, but functions of a large number of variables which it appears to be impossible to express in an analytical form. They may be treated as constants, however, because the functions themselves have a range of variation which is quite restricted. The same applies also to the majority of coefficients which are made use of in hydraulic problems. Because of this, it becomes necessary to determine the average values of k and k' for each type of turbine and for each new device which may be introduced therein, such as new construction of blades, where progress is still possible.

In the present article only simple turbines have been considered, but the same methods may be applied with proper variations to the more complex types. (*La Technique Moderne*, vol. 12, no. 8, Aug. 1920, pp. 332–336, *tA*.)

Short Abstracts of the Month

Errata

The direct-connected high-speed turbo-blower described in the November issue of Mechanical Engineering (p. 630) and referred to editorially on p. 644, was erroneously ascribed to the De Laval Company. This turbo-blower was built by the Rateau-Battu-Smoot Company of New York City.

In the original article in *Power*, from which the abstract in Mechanical Engineering was prepared, it was stated that the blower end of the rotor was made of a nickel-chrome-magnesium steel forging. We are now informed by the manufacturers that this forging was made of nickel-chrome *manganese* steel and not as was stated.

ENGINEERING MATERIALS

Review of the Development of Copper Steel, E. M. Buck. The claim is put forward that tests made by a Committee of the American Society for Testing Materials with the coöperation of the United States Bureau of Standards, together with other data available, proved that by alloying with normal open-hearth or bessemer steel from 0.15 to 0.25 per cent of copper, the rate of corrosion of steel is very much reduced where the products are exposed to alternate attacks of air and moisture. The author also claims that in his investigations he noticed indications which point to a better adherence of paint coatings on copper steel, resulting in a more perfect and longer-continued protection by the paint film.

The manufacture of copper steel has heretofore been largely confined to sheet metal, but it might be extended to other uses. In particular, steel freight cars are mentioned, especially those of the open kind, which suffer greatly from corrosion. (Paper before the American Iron and Steel Institute, New York meeting, Oct. 1920, abstrated through *Iron Age*, vol. 106, no. 18, Oct. 28, 1920, pp. 1109–1110, *g*)

FUEL AND FIRING

Oil-Fuel Installation, Joseph Pope, Mem.Am.Soc.M.E., and Frank G. Philo. Description of the boiler installation of the Savannah (Ga.) Electric Company which has been recently converted from coal to fuel oil and for which unusual efficiencies are claimed.

Since the adoption of fuel oil the boilers have been operated normally at about 250 per cent of their rate of capacity without a single instance of tube trouble throughout seven months of operation, notwithstanding the fact that the boiler feedwater is not entirely free from solid impurities. In the tests carried out at the plant efficiencies (gross) approximating 80 per cent at 300 per cent of boiler ratings have been obtained. Load conditions at the power station were such as to require the developent of high boiler outputs, which made the question of design of the burner of great importance. This steam-atomizing type of burner was not suitable as it gives excellent results at outputs about the rated capacity but not at the higher overloads.

As regards the mechanical-atomizing type of burner the one which had been in use for marine service had not shown as high an efficiency as even the steam-atomizing burner and did not permit to develop very high boiler ratings. The burner finally adopted was a new type developed by the Babcock & Wilcox Company. The original article does not describe its construction and only says that a specially designed orifice disk or tip is employed in which the oil is led to a central circular perforation through tangential grooves and thus attains a violent rotary motion as it is projected through the orifice. The resulting spray takes the form of a widely diverging cone of extremely fine mist. The burner proper is set in the furnace wall at the center of an air register so designed as to impart a whirling motion to the entering air. The rate of combustion is controlled by the temperature and pressure of the oil. The size of orifice in the burner tip also determines the rating, but the burner tips can be obtained in various sizes and are interchangeable, the larger size having a normal capacity of about 14,000 lb. oil per hour at 200 lb. pressure. (*Electrical World*, vol. 76, no. 15, Oct. 9, 1920, pp. 730–732, 3 figs., *de*)

HYDRAULICS

Remarkable Drop in Output of Centrifugal Pumps after Starting, J. C. Dijxhoorn. Observations made by the author indicate that many centrifugal pumps show a gradual falling off in efficiency after running for some time. Two characteristic cases are cited in connection with the large pumps used for pumping the Haarlem mere. In the first the output fell to 30 per cent below the normal, and in the second case a marked increase in the energy consumption was noticeable shortly after the pump was started. On stopping and starting the pump, the normal output and energy consumption were again obtained; but the conditions gradually fell back to those previously discovered. After discussing the influence of a possible accumulation of gas (from a peaty soil) in the suction pipe, the author rejects this explanation as being insufficient. He ascribes the cause to the fact that turbine pumps of the Francis type are designed on the assumption that the inflowing water is moving in an axial and not a rotary direction. This assumption is undoubtedly correct during starting, but it can be readily demonstrated that very little would be required to impart a rotary movement to the incoming water column, i.e., the mass of water would move in a spiral through the pipe. This rotary effect would explain the phenomenon and also the fact that in turbine pumps with a high circumferential speed, and where little or no rotary motion would be imparted to the incoming column of water, this falling-off in output disappears. The author is of opinion that the transmission of this rotary motion from the rotor of the pump back along the incoming water column is considerably accelerated by the presence of large quantities of suspended matter in the water. The obvious solution of the difficulty for low-speed turbine pumps would be the introduction of a rib or ribs in the suction pipe, to prevent a rotary motion from being imparted to the incoming water column. (*De Ingenieur*. Compare *Mechanical World*, vol. 68, no. 1760, Sept. 24, 1920, p. 216, *e*)

METALLURGY (See also Engineering Materials)

Cleaning of Blast-Furnace Gas. Description of the Lodge electrostatic process for rough cleaning of blast-furnace gas as used at the Skinningrove Works in England.

The cleaning is applied to gas used in stoves, boilers and other combustion processes. Wet cleaning has the advantage in that, first, the sensible heat in the gas is lost; and further, power has to be expended in pumping the large volumes of water required for the dust removal. The Lodge plant has been installed to take care of this gas, 0.3 gram of dust per cubic meter in the cleaned gas having been fixed as an arbitrary standard. Essentially the method of operation of the Lodge system does not appear to differ very much from the Cottrell system which has been used in this country for a number of years. The plant appears to be working in a satisfactory manner and not only saves the trouble due to uncleaned stoves and boilers, but also has saved gas, which may have something to do with the former. Furthermore, about 50 tons of dust per week is recovered with 27 per cent content of potash. (Paper before The Iron and Steel Institute, Cardiff meeting, Sept. 1920, abstracted through *Iron Age*, vol. 106, no. 15, Oct. 7, 1920, pp. 928–930, *d*)

MILITARY ENGINEERING

Battleships, Submarine and Aircraft in Naval Warfare

THE DESIGN OF WAR VESSELS AS AFFECTED BY THE WORLD WAR. Rear-Admiral David Watson Taylor. It is not fully possible as yet to answer the question, "What has been the effect of the World War on warship design?" and the opinion of the service has not yet been crystallized and become definite in this respect.

From such data as are available some facts may, however, be considered as established—one of them being the ability of large, modern, heavy-armored ships not only to survive but to continue in action after the most severe punishment.

Taking the battle of Jutland as a test of the defensive qualities of modern ships, one finds that in the entire action only four such ships, all of them of the battle-cruiser type, were lost as a result of the action. The four outstanding facts of interest to the designer, as they emerge in the author's analysis from the smoke and flame of the battle, are—first, the value of armor protection; second, the necessity for the maximum number of major-caliber guns; third, the tactical value of speed; and fourth, the futility of subjecting all the ships to the attack of modern weapons.

Protection of ships is being recognized as one of the most important problems and both the British and American naval services have solved this problem so far as the torpedo has been developed to date. Moreover, although the solutions differ radically in detail, they do not differ much in underlying ideas.

Of the general phases of the war the submarine campaign is given considerable attention. Nations must in the future be prepared to find the submarine playing an important part in attacking and throttling enemy commerce, even on their own coasts. The proposal brought forward at the Peace Conference to abolish the submarine entirely by international agreement was not adopted, wisely as the author thinks, for so long as the possibility of war remains, progress of science and engineering and their application to the art of war cannot successfully be throttled unless there is complete unanimity of sentiment throughout the civilized world.

War experience developed certain facts regarding the submarine. It is essentially an instrument of stealth. Once detected it is at the mercy of a surface vessel, and detection devices, while not perfect yet, have been and will be steadily improved as time goes on. If we had today an accurate device which would locate a submerged submarine with reasonable approximation several miles off and with accuracy when 100 to 200 ft. directly under the surface vessel, the submarine would be obsolete as a weapon of war.

The position of the destroyer as an element of the fighting navy has been particularly enhanced as a result of the war experience, both to attack the enemy and protect its own capital ships. As regards the design of destroyers, the principal demand has been for greater cruising radius and increased shelter and comfort for the personnel.

The rôle played by trawlers, drifters and other small vessels of a similar type has been changed somewhat from that intended at the beginning of the war. Primarily they were to be used as mine sweepers and tenders, but the development of the depth charge made it possible to employ them against submarines, which, in fact, became the principal use to which these small boats were put during the last year and a half of the war. In fact, as time went on, special boats of small sizes were developed for this kind of service, such as the British patrol boats and the United States eagle boats.

Aircraft carriers are particularly mentioned as a new and large type of naval vessel. The actual offensive use of aircraft against naval vessels was little developed during the war.

The author believes that developments in the air will be both along lines of offense against capital ships and of defense of them by auxiliary and offensive aircraft. He states, however, that the big ship which must be protected from projectiles of a ton weight falling at an angle of 30 deg. and fired from ships almost out of sight below the horizon, is not yet in serious danger from bombs carried by present-day aircraft, with chances of hitting small indeed. It seems probable that aircraft will sooner become dangerous to destroyers and light vessels, generally, than to the large ships of the line and even then in order to perform efficiently their functions with the field aircraft must have means for being carried with the fleet, not only on long cruises but actually in battle, which accounts for the development of the aircraft-carrier type of ship.

To sum up, the experience of war, so far as it can be grasped to date, has resulted in demands of every existing type of war vessel which can only be met by increased size and cost. It has resulted in the introduction of only one new type of major importance, namely, the aircraft carrier, but it has introduced a number of small types which will probably survive but need not be constructed in large quantities in time of peace.

While the present tendency is towards increased size and cost, this very fact, under the present financial economical and political conditions in the world, may actually result in the long run in the disappearance from future building programs of these very types, and the substitution for them of smaller and cheaper units made possible by new developments in size and engineering. (*Journal of the Franklin Institute*, vol. 190, no. 2, Aug. 1920, pp. 157–185, illustrated, *gA*)

POWER-PLANT ENGINEERING

Soil Vibration Due to Running Machinery and Methods of Damping It

TRANSMISSION TO A DISTANCE OF GROUND VIBRATIONS DUE TO MACHINERY WITH RECIPROCATING MASSES. Gerb. Discussion of the transmission of ground vibrations due to reciprocating machinery, in which it is found that such transmission to a distance takes place only through plastic subsoil. The vibrations propagate in the form of surface waves. Recommendations are made as to means of avoiding such phenomena.

At the end of 1914 in the Royal Munitions Factory in Danzig a horizontal tandem steam engine of 650 to 850 hp. was installed and when it began to run it set into vibration a number of houses in the neighborhood, some of which were located as far away as 300 m. (say, 1000 ft.). The engine foundation itself was soon split by a horizontal crack in such a manner that the upper and lower parts moved with respect to each other when the engine was running. The free mass forces of the engine in the horizontal and vertical directions amounted to about 10,000 kg. (say, 22,000 lb.) and observation in the houses affected by vibration indicated that the vibrations corresponded to an engine speed of between 160 and 180 r.p.m.

Careful measurements have further indicated that the direction of vibration of the masses did not at all coincide, as might have been expected, with the direction of the reciprocating masses in the engine and that rather the masses vibrated regularly in the direction of the axis of the minimum moment of inertia of the house foundation, hence, at times, normally to the direction of motion of the reciprocating masses of the engine.

The vibrations were of maximum value in the upper floors of the houses but did not grow in proportion to the distance from the ground. An interesting feature lies in the fact that the vibration phenomena were limited to the houses themselves, and the apparatus used for their discovery had not shown any on the ground proper, even in the immediate proximity of the engine. Likewise, it has not proved possible to establish any law for the variation of the accelerations with the distance from the source of vibration.

Only horizontal accelerations were established in the houses, and no measurements of vertical vibrations have been made.

Because of the fact that no vertical accelerations in the houses had been discovered it was assumed that the horizontal accelerations had been transmitted by the plastic stratum of the ground and it has been proposed to isolate the vibrating machine from the surrounding structures by means of a ditch. This means has, however, proved ineffective here, as it did in some other cases, because it is not the solid surface layer of the ground but the plastic subsoil that transmits the vibrations, and this being the case, the only way to prevent the transmission of vibrations is to obviate their transmission from the source to a plastic subsoil body. This cannot be done by insulating layers at the foundation, as materials used for such insulating layers, such as felt, cork, etc., are perfectly capable of taking up vibrations of the higher frequencies propagated as noises, but are not elastic enough as compared with the elastic subsoil and cannot take up elastically horizontal acting forces.

The only truly reliable method of procedure is to attack the evil at the source and to eliminate the generation of vibration by a proper balancing of the reciprocating masses. This can be done in the engine itself only if it has not less than six cylinders. It is, however, possible to do this by special appliances even in a single-cylinder engine. This is based on the fact that horizontally acting free masses in crankshaft drives produce vibrations of the same frequency as the rotative speed of the engine, and, in addition to this, that higher vibrations have a double frequency. As shown in Fig. 1, the basic frequency can be ironed out by two balancing masses *a*, rotating at the same speed as the engine but in an opposite direction, which eliminates the component of centrifugal force acting at right angles to the direction of motion of the reciprocating masses. For the same reason and also in order to prevent the appearance of moments, the weight which balances out the vibrations of double frequency is divided into four parts *b* rotating at a speed double that of the engine. In this way the diagram of the centrifugal forces developed coincides at all rotative speeds with the diagram of the free horizontal forces in the engine. Since, however, the direction of the former is opposite to the direction of the latter and occurs in the same space in which the free forces of the engine operate, theoretically no forces or moments can be transmitted to the foundation. The device shown is driven from the camshaft and consumes a very small amount of power as it has only to overcome the comparatively slight friction in the ball bearings and gears. It is, however, necessary that the connection with the engine body should be strong enough to withstand the stresses produced. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, no. 38, Sept. 18, 1920, pp. 759–760, 2 figs., *dp*)

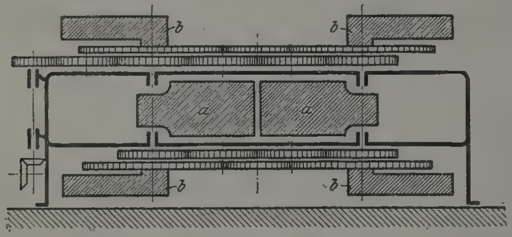

Fig. 1 Device for Balancing Reciprocating Forces in Horizontal Engines of Less Than Six Cylinders

Device for Cutting Off Last Expansion Stage of Turbine from the Exhaust Main

Low-Pressure Steam Control Device, J. W. Smith. In a mixed-pressure steam-turbine and electric-generator installation placed in the power station of an English factory there was no provision made for automatically cutting off the last expansion stage of the turbine from the exhaust main when the supply of exhaust steam failed.

When the air supply of this steam fell below the quantity which could be passed by the low-pressure starting valve a partial vacuum was induced in the exhaust main, which, in this case, is about 400 yd. long, with the inevitable result that air was drawn in through some leaky joint or open drain cock. The starting valve could be regulated by hand to pass only the proper quantity of exhaust steam, but such a solution of the problem was troublesome and would mean that one man's whole time would be occupied. Instead it was solved by putting in an automatically operative controller.

First, there is a low-pressure receiver which diminishes the fluctuations in pressure of the exhaust steam from steam-driven machinery, such as steam hammers and non-condensing steam pumps. After leaving the receiver (Fig. 2) the exhaust steam enters the low-pressure chest through pipe *C*, then passing downward through the starting valve and upward through the emergency stop valve and the governor throttle valve into the turbine.

The turbine steam chest is fitted here with an emergency trip-stop valve *A* which closes upward and the spindle passes vertically through the bottom governor. This valve is of a piston type and is a duplicate of the governor throttle valve *B* fitted immediately above it. As arranged by the makers it was connected to its opening lever by a pair of short links *C*. These links were replaced by some longer ones with a distance piece riveted between their ends to form a flat surface *D*, and the bottom holes of the new links were elongated to allow the valve to be closed without raising the original operating lever. Under this against the wall of the condenser pit, was fitted a lever about 4 ft. 6 in. long. At about 3 in. from its fulcrum a vertical rod was jointed which passed through a suitable guide so that its end was just clear of the flat bottom of the new valve links when the new lever was at the bottom of its travel. The end of the lever had to be raised about 12 in. to close the valve, and suitable guides and stops were provided to prevent all undue stresses. Owing to the 18-to-1 leverage provided, the effect of the friction of the valve and spindle was negligible at the end of the lever. The steam receiver *E*, the shell of an old Lancashire boiler, has a siphon drain *F* connected to one end plate about 3 in. above the bottom of the shell. In consequence of the position of this drain there was always a quantity of water lying in the bottom of the shell, the surface of which measured roughly 3 ft. by 20 ft. At the other end of the steam receiver the old blow-off cock fitting *G* on the bottom of the shell had been blanked off. A $2\frac{1}{2}$-in. cock was fitted to this blow-off cock branch one week end, and, working back from that the following week, an old 7-ft. length of 8-in. cast iron pipe was rigged up in a vertical position and supported from the floor by a length of $2\frac{1}{2}$-in. pipe with a blank flange at the bottom. This pipe formed an excellent float chamber with sufficient head of water to seal the maximum pressure permissible in the receiver. Owing to the wide ratio between the surface of the water exposed to the steam on one leg of the submerged bend, and the surface of the water exposed to atmospheric pressure on the other leg of the submerged bend, about 60 sq. ft. to 50 sq. in., the rise of water in the float chamber was almost 2.3 ft. per lb. pressure in the receiver. A galvanized-iron float was provided, 6 in. diam. by 12 in. deep, with

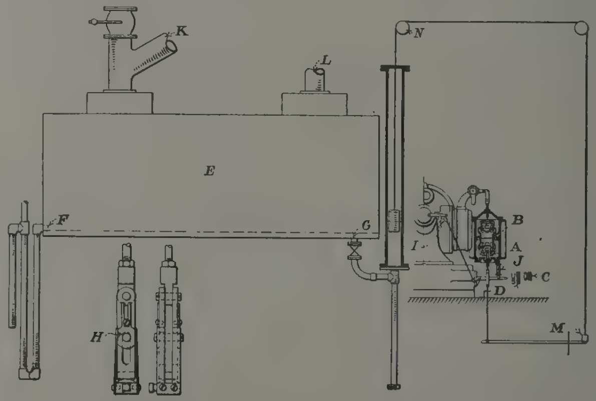

Fig. 2 Diagram of Controller Used on a Mixed-Pressure Steam Turbine at the Gloucester Wagon Company's Central Power Station

a stretcher bar across its open top to enable it to be suspended correctly. This was filled with water and connected to the new lever by a flexible steel wire rope passing over two guide pulleys. Sufficient weight was then added to the lever to cause the float to be normally half submerged when the lever was clear of both stops.

It was found in tests that the displacement of only 2 in. of water above or below the center of the float is sufficient to operate the valve and that only a $^1/_2$-lb. variation of steam pressure is required to move the valve from "open" to "shut," or vice versa. Moreover, it is also stated that the device has been in constant use for eight years without any repairs. (Paper read before the Gloucestershire Engineering Society, abstracted through *Power House*, vol. 13, no. 19, Oct. 5, 1920, pp. 437–439, 2 figs., *d*)

Water-Indicating Devices for Locomotives

Government Tests of Water-Indicating Devices. For the purpose of determining, if possible, the general outline of the flow of water existing at the back head, when high evaporation was taking place, tests were made on one of the U. S. Railroad Administration standardized 2–10–2-type locomotives.

In these tests it was found that the way the top connection to the water column is made affects very materially the general outline assumed by the water on the back head. It also appeared that under certain conditions dry steam was being obtained both at the back knuckle and further ahead, which is believed, however, to be partly due to the exceedingly good water used in this test.

Further tests were made to determine the approximate outline and proportions of the water conditions existing at the back boiler head while the locomotive is being operated with heavy throttle, or when steam is being rapidly generated and simultaneously escaping from the boiler. These tests covered the distance of 808 miles in bad-water districts on approximately level track with a locomotive of the heavy 2–8–2-type equipped with superheater and duplex stoker.

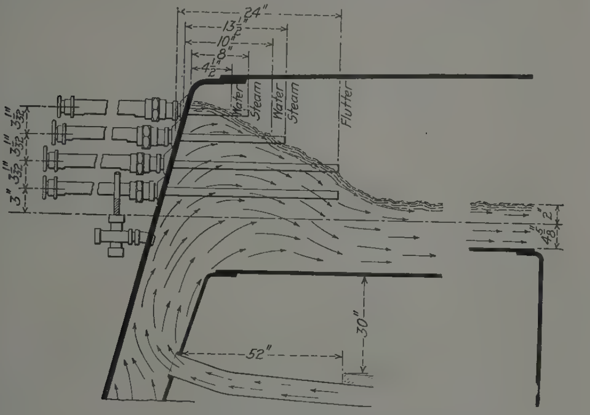

Fig. 3 Exploration Tubes Used as Water-Indicating Devices in Tests of Water Circulation in Locomotives

The test appliances are shown in Fig. 3, the apparatus consisting of four gage cocks applied directly in the back head near the knuckle; one water column to which three gage cocks and one water glass were attached; one water glass with a 9-in. reading, standard application, with both top and bottom cocks entering boiler back head direct; one water glass applied for experimental purposes with a bottom cock entering the boiler head on back knuckle and one entering 13 in. ahead of the back knuckle, together with four exploration tubes or sliding gage cocks. Fig. 3 shows a side elevation of these exploration tubes.

Here it was found that while generally the same conditions prevail as in other tests, the outline of water reached a higher elevation and greater proportions at the back head than in the previous tests, which is due probably to the poor water used here.

Tests were also made on a switching locomotive in which, in addition to the usual apparatus, a glass tube was inserted in the top of the wrapper sheet which permitted the use of an electric light inside the boiler, clearly illuminating the steam space over the crown sheets. Five bull's-eye sight glasses were distributed so that the action of water in the back head could be seen while under steam pressure, as shown in Fig. 4.

Both main rods were disconnected, crossheads blocked at end of stroke and valve stems disconnected and so placed that steam was discharged through the exhaust nozzle and stack, creating a forced draft on the fire, representing as nearly operating conditions as possible.

When the throttle was closed and no steam escaping from the boiler the surface of the water was approximately level, with a distinct circulation noted from back to front and from the sides toward the center of the crown sheet. When the safety valves lifted, the water rose with fountain effect, around the edges of the firebox, from 1 in. to 2 in., and the circulation was materially increased.

When the throttle was opened and steam was being generated and escaping from the boiler in greater volume, the level of water throughout the boiler was seen to rise 1 in. to $1^1/_2$ in., which rise was registered by the water glass, and a marked flow of water, with fountain effect, was observed rising around the firebox at the back head and wrapper sheets, reaching a height above that over the remaining portion of the crown sheet of approximately 2 in. to 4 in., in proportion to the amount of steam being generated and simultaneously escaping from the boiler.

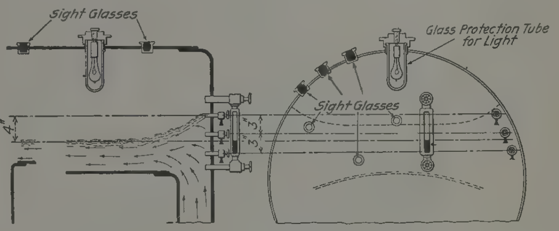

Fig. 4 Arrangement of Lights and Observation Glasses in Boiler to Determine Water Conditions

The important feature to be noted is that this height of water, as seen at the back head, was approximately 4 in. at its maximum, and was registered by the gage cocks, while at the same time it could be seen that the water glass was registering the level further ahead over the crown sheet.

Among the interesting features observed were the size of the steam bubbles which were approximately $^1/_4$ in. to $^3/_8$ in. in diameter, and the rapidity with which they were seen to rise to the surface and explode. The size and number of these steam bubbles, which were seen rapidly rising next to the back head, explain one of the physical reasons for the increased height of water around the crown sheet and the rapid circulation attained.

These observations establish beyond question that when steam is being generated and escaping there is an upward movement of water at the back head of the locomotive boiler which carries it above that further ahead over the crown sheet, and that the gage cocks, when applied directly in the boiler, register this rise of water and do not indicate the level further ahead, while the water glass registers the level of water further ahead and not the fountain of water at the back head.

Among the general observations made attention may be called to the following: It is recognized that the volume of water in the boiler increases in proportion to the amount of steam being generated and in the same ratio that the steam bubbles below the surface are formed and expanded, the volume of which depends to a very considerable extent upon the purity of the water in the boiler its ability to readily release the steam being generated, consequently increasing the height of water in the same proportion, which height is registered by the water glass.

Gage cocks secured directly in the boiler have been shown to be incapable of correctly indicating the general water level and an arrangement is described and illustrated in the report which is claimed to be more correct and safe than the ordinary methods. (Report of the Bureau of Locomotive Inspection of the Interstate Commerce Commission, abstracted through *Railway Me-*

chanical Engineer, vol. 94, no. 10, Oct. 1920, pp. 630–633. This is the second part of the report, the first part having been given in the *Railway Mechanical Engineer*, for Sept. 1920. *dep*)

POWER TRANSMISSION

Liquid Variable-Speed Transmission Gear

Carey Oil Transmission System. Description of the pump used for an oil transmission system. The rotor (Fig. 5) consists of a solid block of steel *R* in which five recesses are formed to act as cylinders. Each recess is fitted with a glass-hard steel bush in which works an ordinary steel ball acting as a piston and having a total clearance of about one one-thousandth of an inch. These ball pistons were in conjunction with a track *T* of glass-hard steel, the track being carried by a cast-steel ring *S* which works between guides *P* formed in the cast-iron main casing or pump body. This ring may be moved to different positions in a vertical direction between the guides so that varying degrees of eccentricity may be obtained between the center of the track and the axis of the rotor, either above or below the center line. When the centers of both parts coincide, no relative radial motion takes place between the rotor and the ball pistons. As the degree of eccentricity is increased the quantity of oil delivered by the pump increases likewise until the limit of travel is reached. When the track engine is raised above the center, flow takes place in one direction and this direction is reversed when the track is moved to a position below the center line.

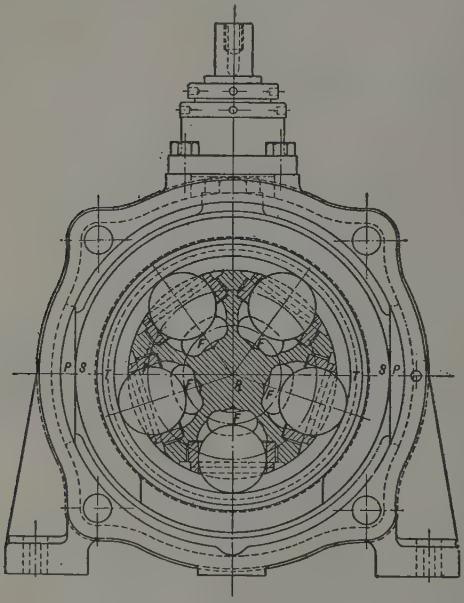

Fig. 5 Cross-Section of Rotor of the Carey Pump

In each of the five cylinder recesses there is a port *F* with a hardened base and a floating valve (not shown in the drawing) having a rocking motion and also a rotating motion so that it can adjust itself to the position of the rotor. This valve carries the inlet and outlet ports.

By combining two machines of this type it is possible to make a variable-speed transmission gear. One machine is driven by a prime mover at constant speed and acting as a variable-stroke pump delivers oil under pressure to the other machine which acts as a hydraulic motor. This can be done by coupling up two Carey machines back to back, but with their respective back covers replaced by a single junction casing which carries the two floating valves and provides the necessary passages for the flow and return of the working fluid. The ratio of speeds between the driving pump and the driven pump is controlled by the lengths of the strokes of the two machines.

It has been found that for speeds up to 500 r.p.m. these transmission gears may be filled with oil, but for higher speeds it is desirable that the rotor should run in air. (*The Engineer*, vol. 130, no. 3377, Sept. 17, 1920, p. 284, 2 figs., *d*)

PRESSES

An Adjustable-Position Press. Description of a press designed and built by the Toledo Machine and Tool Company, Toledo, Ohio, the most interesting feature of which is, that it is operative in either an upright or an inclined position, a turn of the handwheel permitting a change in position. The press is driven by a direct-connected electric motor so arranged that it stays vertical no matter whether the press is in the vertical or inclined position. (*The Iron Trade Review*, vol. 67, no. 17, Oct. 21, 1920, p. 1140, 2 figs., *d*)

RAILWAY ENGINEERING (See also Power-Plant Engineering)

Regan Automatic Train Control System. This system, as installed on the Great Eastern Railway where the Westinghouse brake is employed, consists of a shoe suspended from the center of the rear buffer pin of the engine, an electropneumatic valve behind the steps on the right side, a relay box and release switch on the same side, a battery box and a speed-control device on the right wheel of the controlling nozzle. The equipment on the track consists of a ramp 100 ft. long with inclined ends fixed in the "four-foot" at each signal and electrically connected thereto.

The speed-control device consists of a centrifugal governor mounted upon a baseplate rigidly bolted to the end of the trailing nozzle and accurately centered therewith.

The shoe mechanism consists of a shoe stem, a cylinder and a circuit controller. The upper part of the steam connects to the brake pipe, and as the stem is hollow, it follows that should the shoe be broken off the air would escape and the brake would be automatically applied.

A demonstration of this system was given on the Great Eastern Railway on September 30, 1920, when the speed control was set for 24 miles per hour and the train was stopped from that speed in 225 ft.

In this connection, it may be stated that in an editorial in same issue of *The Engineer* (p. 355–356) automatic train control is advocated for Great Britain and instances are cited of serious accidents which could have been prevented had such a control been available. In fact, it is stated that the Ministry of Transport has appointed a Departmental Committee to consider the whole question.

In discussing the matters to be considered by this new Committee the editorial points out as one having a very serious aspect, the question whether or not the uniform system for the whole of Great Britain should be determined upon. This is particularly important as British locomotives do a considerable amount of running over "foreign" tracks. There is also the question as to what object automatic train control has to achieve; this is, whether or not the driver should have an indication of the state of the running signal which he is unable to see, for example, during fog or falling snow.

An interesting discussion is presented as to the conditions which the track equipment should satisfy. The subject of speed control is also not as simple as it looks, as, for example, it is not easy to insure that a mixed-traffic engine just taken off a fast freight train is properly adjusted for working an express passenger train, and vice versa. (*The Engineer*, vol. 130, no. 3380, Oct. 8, 1920, p. 348, *dg*)

RESEARCH

Progress of Scientific and Industrial Research in England During the Past Year

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1919–1920. From the report presented it would appear that a very active program for research is being steadily pushed ahead in England and that quite substantial funds are available therefor. In particular, it is pointed out that the British industries with an awakening interest in the value of research and of scientific control of manufactures, are making such demands on the available supply of research workers and offering such salaries that the universities face the danger of losing their teaching staffs in the same manner as they did during the war.

Important grants have been made to students and independent workers as well as to provide professors with research assistants of scientific standing. No conditions are attached to the grants made to workers whose sole aim is the extension of knowledge, either as to the line of their work or as to the use of the results. The only condition is that if they propose to make commercial use of their discoveries they must consult the Committee for Scientific and Industrial Research, because at this point they are leaving the field of pure investigation; otherwise, however, their tenure of the grant is perfectly free.

There are now 18 research associations of various character in England licensed by the Committee and covering many fields of industry, and five other associations have been approved but have not received their licenses.

The Department of Research is committed to a total expenditure of £450,000 on account of the established research associations and to a further expenditure of at least £120,000 on account of those approved but not yet licensed. The total committments may, however, reach £800,000.

It is claimed that the industries fully realize already the importance of research, though they have not yet quite come to a full appreciation of its difficulty or its full worth. The best proof that the value of research is realized is shown that large funds for the endowment of research are being raised privately; for example, the cotton industry is hoping to raise £250,000 for that purpose.

The report mentions more or less briefly the method of organization of research and the subjects which occupy the attention of the various boards and committees.

In this connection it is of interest to note that the question of fuel is considered to be a basic problem of the greatest national importance. As regards the Committee of Research, it is in the hands of a fuel research board. There are numerous other boards covering the vast field of investigation.

As a sample of the work of these committees may be mentioned the following quotation describing the Zirconium Inquiry Committee:

> It was frequently suggested during the war that zirconium-containing steels of remarkable hardness had been produced and were being employed by enemy countries in the production of light armor for aeroplanes and tanks. In July 1918, at the request of the Ministry of Munitions, a Zirconium Inquiry Committee was set up with the object of investigating the preparation of ferro-zirconium and, from the latter, of zirconium-containing steels. The experimental difficulties in the way of production of a true alloy of iron and zirconium were numerous and severe, and after much work they were only partly overcome. It was found possible to prepare, in 50-lb. batches, a ferro-zirconium containing, however, a considerable portion of carbon, while much of the zirconium in the material was present as carbide. It was consequently very doubtful whether the zirconium in this material could be transferred into a melt of steel. In the meantime numerous inquiries have failed to discover any source of supply of ferro-zirconium containing only small proportions of carbon and silicon, or any evidence that zirconium added to steel conveys to it any beneficial quality. Further, the examination of samples of light armor of enemy origin has not revealed the presence of zirconium.
>
> After the conclusion of the war the importance of the inquiry diminished and in consequence the Committee were of opinion that their investigations should be concluded. We have recently received their report and have recommended that it be communicated to the fighting services.

In an appendix some information is given on the developments of the organization of research in the Overseas Dominions and in the allied and associated countries.

In particular, there is under consideration the proposal for the establishment of a National Institute for Canada, on which the report of the Committee was unanimously adopted by the Canadian House of Commons in May last. The cost of building and equipping the Institute is estimated at $600,000 and approximately $50,000 is required for the salaries of the staff during the first year. The proposed Institute will exercise functions akin to those of the Bureau of Standards in Washington. It is also anticipated that the Institute will play an important part in fostering the movement for coöperative research among the industries of Canada by placing laboratories and (if necessary) staffs at the disposal of coöperative research guilds when they are not in a position to maintain laboratories of their own.

There are already several organizations in Canada established with a view to industrial research, such as, for example, the Fuel Research Board appointed to deal with the standardization of coals through the Dominion, and the Peat Commission which has already successfully developed a bog at Alfred, Ontario. (Abstract of Fifth Annual Report of the Committee of the Privy Council for Scientific and Industrial Research, presented to Parliament by Command by His Majesty and published in London in 1920, 120 pp., *g*)

SPECIAL MACHINERY (See Power Transmission)

STEAM ENGINEERING

German Tests on Steam Nozzles and Diffusors

Steam Nozzles. A German engineer, Friedrich Muller, of Berlin, has recently published certain data of an investigation dealing with tests on a steam diffuser.

Investigations dealing with the inner processes in the conversion of pressure into velocity in nozzles have not entirely cleared up the theory of steam flow; for example, no one has succeeded thus far in giving a complete expression for processes which take place under the assumption of a unidimensional flow, and Professor Stodola in an article in *Zeitschrift des Vereines deutscher Ingenieure* (1919) states that these processes will not be made clear until laws are established on a polydimensional conception of flow.

In the experiments described by Muller, carried out in the laboratory of machine design of the Technical High School, Charlottenburg, live steam of various temperatures and pressures was expanded in a DeLaval nozzle. The nozzle was attached in the usual manner to a movable arm of a reaction device. When at dead center this arm was held rigid and the steam flowed crosswise toward the exit from the nozzle of the diffuser and was then condensed on the pipes of a surface condenser. A valve was provided to make it possible to create the desired back pressure in back of the diffusor. The state of the steam previous to the entrance into the nozzle was determined by measuring the steam pressure by a manometer and likewise by measuring the respective temperatures.

In the tests the following two concepts were followed up: first the variable state of the steam with the given nozzle; and second, different nozzles with a corresponding initial state of the steam.

The data of the tests are presented in the original publication in eight tables. Among other things, this investigation led to the conclusion that we have not yet the means necessary to produce the designed expansion, but we can by proper devices make the nozzles capable of satisfying given requirements of pressure conditions. On the other hand, these tests have been sufficient to throw a great deal of light on what takes place in the diffusors. Hitherto information available was only sufficient to determine the shape of the diffusor when the given weight of steam expanded in a nozzle had to be compressed to a given back pressure. The author proposes to proceed in the opposite direction, that is, to pay no attention at first to the shape of the diffusor and instead to determine that pressure both in front and back of the diffusor which gives the best efficiency.

By efficiency of the diffusor is, therefore, understood here the ratio of two heat heads, one being the expansion of the steam in the nozzle and the other determinable by the pressures in front and in back of the diffusor. This latter heat head is to be measured on the adiabatic curve of the nozzle expansion.

The most reliable data have been obtained in the tests presented in Fig. 6. The curves *d* and *e* give the most desirable variations of pressure. According to the general theory of nozzles, the following two equations are available: first, equation of continuity:

$$W_{pr} = \frac{G \times v_{14}}{F_{m\ Diff}} \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

second, equation of sound velocity:

$$W_{th} = g \times k \times p_{14} \times v_{14} \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

in which the following notation is used:

W_{pr} = velocity in meters per second computed on the assumption of continuity

W_{th} = velocity of sound in meters per second
G = weight of steam flowing per second in kg.
g = 9.81 meters per sec. per sec.
k = ratio of specific heat at constant pressure to specific heat at constant volume

$$\psi = \sqrt{g \times k \times \left(\frac{2}{k+1}\right)^{(k+1)/(k-1)}}$$

p = pressure in kg. per sq. m. available at any time
v = available specific volume in cu. m. per kg.
$f_{m\ Düse}$ = minimum cross-section of the nozzle in sq. m. (*Düse* means nozzle)
$F_{m\ Diff}$ = minimum cross-section of the diffusor in sq. m.

If we insert the experimental values as given in Fig. 6 into Equations [1] and [2], we find that the variation of pressure is free from shocks and the diffusor develops its best efficiency when it is assumed that

$$\frac{W_{th}}{W_{pr}} = 1 \quad\text{[3]}$$

Since the maximum, as has been found elsewhere, occurs with a back pressure of about 0.435 atmos. abs., it follows that

$$\frac{Gv_{14}}{F_{m\ Diff}} = \sqrt{g \times k \times p_{14} \times v_{14}} \quad\text{[3a]}$$

which when simplified reduces to

$$\left(\frac{G}{F_{m\ Diff}}\right)^2 = (g \times k) - \frac{p_{14}}{v_{14}} \quad\text{[4]}$$

Equation [4] becomes similar to the general nozzle equation

$$G = F_{m\ Düse} \times \psi \sqrt{\frac{p^1}{v^1}} \quad\text{[4a]}$$

the latter is expressed in the form

$$\left(\frac{G}{F_{m\ Düse}}\right)^2 = (g \times k)\,\frac{p_m}{v_m} \quad\text{[5]}$$

By combining Equations [1] and [2] the conclusion may be arrived at that a definite ratio of pressures may characterize a diffusor just as it does nozzles. It is further found that most likely when the flow in a diffusor is free from shocks, there is a very definite value determining the ratio between pressure in the smallest cross-section p_{14} to end pressure p_8. The tests have shown that this ratio for the given turbine was equal to $p_{14}/p_8 = 0.6$. The author expressed it, however, in another form, namely,

$$\frac{p_{14}}{p_8} = \left(\frac{2}{k+1}\right)^{k/(k-1)} \quad\text{[6]}$$

where k, in the case of diffusors, has the usual values for saturated steam. Substituting this in Equation [3a] or its derivative, he gets

$$G = F_{m\ Diff} \times \psi \times \sqrt{\frac{p_8}{v_8}} \quad\text{[6a]}$$

Furthermore, as the weight of the steam flowing per unit of time is the same for the nozzle and the diffusor and assuming that $\psi_{Düse}$ for the nozzle is equal to ψ_{Diff} for the diffusor, it appears that the following relation holds good for the ratio between the minimum cross-section to the minimum cross-section to the diffusor.

$$\frac{F_{m\ Diff}}{F_{m\ Düse}} = \frac{\sqrt{\frac{p_1}{v_1}}}{\sqrt{\frac{p_8}{v_8}}} \quad\text{[7]}$$

Moreover, this equation was proved to be approximately correct experimentally and the following values have been found to hold good:

$F_{m\ Düse}$ = 5.11 sq. cm.
p_1 = 3 atmos. abs.
v_1 = 0.911 cu. m. per kg.
$D_{m\ Diff}$ = 30.2 sq. cm.
p_8 = 0.41 atmos. abs.
v_8 = 5 cu. m. per kg.
$F_{m\ Diff}/F_{m\ Düse}$ = 1.82/0.287.

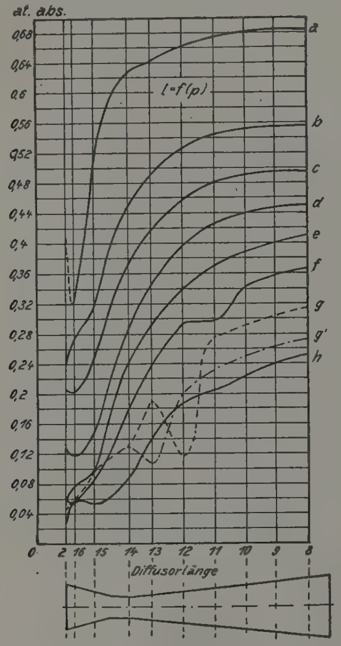

FIG. 6 CURVES OBTAINED IN TESTS ON A STEAM DIFFUSOR AT THE MACHINE CONSTRUCTION LABORATORY OF THE TECHNICAL HIGH SCHOOL IN CHARLOTTENBURG

(*at. abs.*, atmospheres absolute; *Diffusorlänge*, length of diffusor.)

Fig. 6 among other things, explains the pressure variations, since with an excessively large ratio of pressures the steam finds in the convergent and divergent parts of the nozzle somewhere cross-sections where oscillations of pressure occur. If, however, the pressure ratio is below the theoretically correct one, then the minimum cross-section must be smaller than that actually available and because of this the steam does not lie at the walls but forms a diffusor of its own. (Mitteilungen des Maschinenbau-Laboratoriums in Berlin, abstracted through *Der Praktische Maschinen-Konstrukteur*, vol. 53, no. 31, Aug. 5, 1920, pp. 280–282, 1 fig., *et*)

TESTING MATERIALS

NEW MAGNETIC TESTING APPARATUS. Description of a new device for the magnetic testing of steel which its inventor, Dr. Charles W. Burrows (Mem.Am.Soc.M.E.), calls the defectoscope.

The big advantage of magnetic testing is, first, that it can be applied to the article in its finished form; and second, that it in no way affects the article or mars it.

When a test is made by means of magnetic defectoscope the bar must first be magnetized. This is effected by means of a relatively short solenoid energized by a direct current of such value that the magnetism is carried well beyond the knee of the induction curve. Next, a detector is used to discover magnetic variations of the bar. This detector consists of two test coils having the same number of turns and surrounding the specimen. Detection is made by shifting the detector from one position to another along the length of the test material, and as it occupies different positions it is threaded by an induction which depends upon the nature of the specimen. If the specimen is not quite uniform the magnetic induction threading one of the coils and the detector is different from the magnetic induction threading the other coil. The result is that the electromotive force generated in one of the test coils is different from that generated in the second test coil and this differential electromotive force indicates lack of homogeneity in the specimen and can be read from the indicator, in this case a heavily damped short-period D'Arsonval galvanometer provided with a recorder which is essentially a photographic film caused to move uniformly across a small slit through whose opening a spot of light is reflected by the galvanometer. The instrument is, of course, provided with the control box containing the necessary electrical switches, rheostats, and instruments.

In the original article it is shown how the defectoscope may be applied to the examination of rails, rods, wire, cable, etc. Among other things, the instrument may be readily applied to the examination of strip material such as is used in the manufacture of various saws and coil springs.

It would appear that for the examination of material which possesses circular symmetry, test methods have to be applied somewhat different from those used for rectilinear material. In fact, small circular objects have a special method of their own for magnetic examination, namely, examination in a rotating magnetic field and measurement of the magnetic torque exerted on the specimen by the rotating magnetic field, so that it is really not the permeability but rather the magnetic hysteresis of the material that is measured. (*Iron Age*, vol. 106, no. 18, Oct. 28, 1920, pp. 1125–1128, 7 figs., *d*)

TRANSPORTATION

Motor Transportation of Steel Products

TRUCK TRANSPORTATION IN THE STEEL INDUSTRY. Myers L. Feiser. More steel is said to have been moved by motor truck during the past several months than ever before in this country, due to the demoralized traffic conditions which reached an acute stage last April as a result of the outlaw railroad strike. Steel recently carried in motor trucks from mill to consumer or to cars for shipment to consumer is estimated at more than 100,000 tons monthly, although no reliable records are available to cover the entire industry. Some makers, have, however, tabulated their truck tonnages, and one in the Pittsburgh district reports 25,000 tons in a single month and an average close to this figure for some time.

In normal times distance has been one of the factors limiting the use of trucks in steel hauling, but in the past few months unusually long hauls have been resorted to. One user of sheets in New England, for example, sent a truck all the way to Pittsburgh for sheet bars. Another buyer of sheets sent his truck from Philadelphia to Niles, Ohio, for a quantity of black sheets. These distances are exceptional, however, and most of the trucking of steel recently has been on an average of perhaps 50 miles.

The main sizes of trucks used for steel carrying have been 5-ton and 3-ton. The costs varied widely, but the demand for steel has been such as to make the cost in some cases a minor factor.

The organization of trucking with the various companies has been different, few, if any, steel makers maintaining a trucking service of their own for their customers, though some, as, for example, the Republic Iron and Steel Company, Youngstown, Ohio, have trucks for their own requirements.

Motor-truck transportation apparently appealed particularly to consumers of high-grade steels, which steels are not necessarily required in large quantities, especially that regular motor routes have been established between cities with scheduled stops at plants and towns on the way. It has been found that the charges over these routes vary, but when material is urgently required the extra cost represents a premium which the consumer is willing to pay in order to obtain delivery.

A canvass of steel manufacturers has shown that the increase in the movement of material by truck is held up by the condition of roads, and that otherwise with proper equipment, truck transportation of steel and iron products especially for short distances has apparently a promising future. It would appear, however, that under normal conditions the question of cost will have a decided influence. (*The Iron Trade Review*, vol. 67, no. 17, Oct. 21, 1920, pp. 1127–1129, 5 figs., *dg*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

FOUNDATIONS FOR MACHINERY

(*Continued from page 672*)

to bring the system to rest. It is still more important, however, to note the fact that we introduced the additional degree of freedom precisely in the sense of action of the disturbing agency, that is, in the sense of the plane of the figure and not at right angles thereto; or, say, in an up-and-down sense, as for instance by providing a coil spring instead of joint H.

THE BASIS OF FOUNDATION DESIGN

This, then, will be taken as basis for our further discussion: In contemplating the design of a foundation we shall always separate those directions (or axes of instantaneous rotation) about which the system cannot (or at least is not likely to) oscillate from those directions (or instantaneous axes) about which the system is more or less certain to vibrate. We next shall select a "steady" point from purely practical considerations, and finally devise such means of controlling the "free periods" of the system as will secure the desired degree of remoteness from synchronism under the actual operative speed. Such means of course will be springs, exceedingly heavy, and not in the least calculated to allow of any free wabbling of the system. They will also be adjustable so that the desired periods may be readily varied within wide limits; and in general structurally arranged to introduce as few changes as possible.

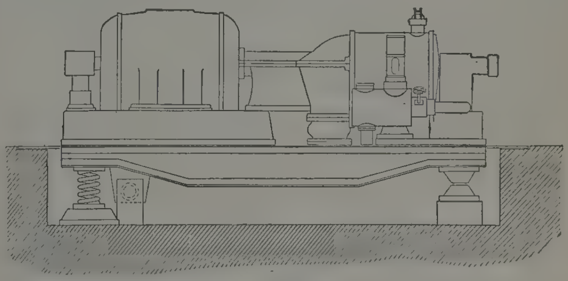

FIG. 3 APPLICATION OF AUTHOR'S DESIGN TO A TURBO-GENERATOR

The author feels that to submit too many particulars as regards the detailed designs of such an arrangement would certainly defeat the purpose of this paper. Considering, therefore, only one type of apparatus, a turbo-generator (Fig. 3), we must start out with the selection of the steady point. We will naturally place it as near the steam main as possible (not to the exclusion, of course, of a suitable expansion joint), as under all conditions, should there be a choice of position, preference should be given to that point as far as possible from the center of gravity of the system, so that any static unbalance (whipping, etc.), would be made to act not as a force *upon*, but as a moment *about*, that steady point. Such point should actually be made as steady as possible and no trouble should be spared in providing suitable piling or digging down to the solid ground and constructing suitable footings.

The next problem is to design a substructure adapted to receive the bedplate of the apparatus and made stiff enough so as to eliminate any "periods" of its own. This bedplate may be made of structural steel or of reinforced concrete, in which latter case the ends thereof may be made of cast iron. The substructure is supported upon the steady point either by a ball-and-socket arrangement, or is simply bolted at that point to the floor plate underneath by a bolt which need not necessarily be very light but which must be arranged in a manner to secure the minimum area of actual contact. Remembering that in apparatus of this sort the tendency to oscillate about the axis x (Fig. 1) is always rather negligible, we have practically only two degrees of freedom and only two periods to adjust so as to have them well out of the limits of the operative speed. Hence the two sets of springs, one to take care of the period corresponding to oscillation in the vertical plane, the other to control motion in the horizontal plane. It should not be imagined, however, that these springs will necessarily be very light; they will always have considerable stiffness, but their function is that of being the only members that *can* yield and the whole situation is controlled by the proper choice of these yielding elements.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Department of Scientific and Industrial Research

THE Fifth Annual Report of the Committee of the Privy Council for Scientific and Industrial Research has now been issued (Cmd 905) and may be obtained (price 1—by post 1/2½) through any bookseller or direct from H. M. Stationery Office at the following addresses: Imperial House, Kingsway, London, W.C. 2; 28 Abingdon Street, London, S.W. 1; 37 Peter Street, Manchester; 1 St. Andrew's Crescent, Cardiff; 23 Forth Street, Edinburgh; or from E. Ponsonby Ltd., 116 Grafton St., Dublin.

Besides a detailed account of the work of the Scientific and Industrial Research Department during the year 1919–1920, this report contains a review of the activities of the Department during the five years that have passed since the establishment of the Committee of the Privy Council for Scientific and Industrial Research statistics of the grants made and sums expended over this period and an outline of the development of coöperative association for industrial research.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A15–20. Purity of Electrolytic Oxygen. An instrument built by the Leeds & Northrup Company for determining the purity of electrolytic oxygen by thermal conductivity has been calibrated at the Bureau of Standards. A number of manufacturers of chemical products intend to apply this method of manufacture for several of their processes. A 16-point gas analysis prepared for the helium plant at Fort Worth is well under way. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A16–20. Reflectometer. The Bureau of Standards has recently developed a reflectometer for measuring the light from walls, ceilings and other objects. Serious errors have been made in previous determinations of reflection factors of most materials. Results have been confirmed by other experimenters. The instrument will be described before the convention of the Illuminating Engineering Society during November and in a scientific paper of the Bureau of Standards. An original form of the instrument was described in Scientific Paper 391 and also in the *Journal of the Optical Society* for January, 1920. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemistry, General and Physical A1–20. Colloid Chemistry. The Committee of the British Association for the advancement of Science has issued its third report on Colloid Chemistry and its general and industrial applications. This has been published for the Department of Scientific and Industrial Research of Great Britain. The report includes the following sections:

1 Colloid Chemistry of Soap, Part I—Solutions. By Prof. J. W. McBain.
2 Ultramicroscopy. By G. King, M.Sc., F.I.C.
3 Solubility of Gases in Colloidal Solutions. By G. King, M.Sc., F.I.C.
4 Electrical Charge on Colloids. By J. A. Wilson.
5 Imbibition of Gels, Part I. By J. A. Wilson.

The subjects dealt with under the second head are:

6 Imbibition of Gels, Part II—Industrial Applications. By J. A. Wilson.
7 Colloid Problems in Bread Making. By R. Whymper.
8 Colloid Chemistry in Photography. By Dr. R. E. Slade.
9 Collodion in Photography. By H. W. Greenwood.
10 Cellulose Esters. By Foster Sproxton, B.Sc., F.I.C.
11 Colloid Chemistry of Petroleum. By Dr. A. E. Dunstan.
12 Asphalt. By Clifford Richardson, M.Am.Soc., C.E.F.C.S.
13 Varnishes, Paints and Pigments. By Dr. R. S. Morrell.
14 Clays and Clay Products. By A. B. Searle.

The price of the report is 2s.6d. and it may be obtained from Imperial House, Kingsway, London, W.C. 2.

The first report of the Committee issued in 1917 may be obtained from the British Association, Burlington House, London W.1., price 2s., and the second report from Imperial House, Kingsway, London W.C. 2.

Explosives and Explosions A1–20. Liquid-Oxygen Explosives in Germany. Mr. George S. Rice has made report No. 2163 to the Bureau of Mines on this subject. The report shows that 136 plants with a total capacity of 3797 liters of liquid oxygen per hour have been installed in the coal, iron, potash and salt mines, as well as for military purposes in various parts of Germany and in the French coal mines. Address F. G. Cottrell, Director, Bureau of Mines, Washington, D. C.

Foundry Equipment, Materials and Methods A1–20. Metals Alloyed with Gray-Iron Castings. Experiments have been made to determine if any benefit results by adding such metals as zirconium, aluminum and uranium to gray cast iron. Zirconium in a ferroalloy containing 35 per cent of zirconium was added to the iron in the ladle in the proportions of 2 lb. of alloy per ton of iron. The analysis showed 0.03 per cent zirconium in the castings. Cylinders and test bars were cast from this metal. Transverse tests showed an average of 3000 lb. and tensile tests, above 25,000 lb. per sq. in. These results are approximately the same as those obtained with regular run of castings. The cylinders machined more easily than those without zirconium and were much softer. The castings were close-grained and clear. The addition of ferrozirconium increased the cost about $2 per ton. Uranium was added in the form of an aluminum alloy containing 96 per cent aluminum. Three samples were tried containing 0.21 per cent, 0.50 per cent and 1 per cent uranium. Test bars showed the same transverse strength as regular run of castings with a tensile strength slightly lower than those of the regular iron. The castings showed no better machining qualities but were close-grained and clean. The alloys may have a scavenging effect, but the value of the uranium alloys is questionable. Address H. V. Wille, Baldwin Locomotive Works, Philadelphia, Pa.

Fuels, Gas, Tar and Coke A14–20. Water and Petroleum. The Pittsburgh Petroleum Laboratory of the Bureau of Mines has recently developed an improved method for determining water in petroleum emulsions. It is a modification of the familiar procedure of distillation with immiscible solvent. It is described in Report No. 2159 by E. W. Dean and W. A. Jacobs. It is also described by E. W. Dean and V. D. Starke in the *Journal of Industrial and Engineering Chemistry*, vol. 20, May 1920, p. 486. The equipment is made up of standard parts with the exception of the distilling-tube receiver, which can be obtained through the Bureau of Mines, from certain chemical supply houses and an electric heater which may be made from an electric hot plate. Names and addresses of firms may be obtained from the Bureau on request. The method may be used with fuel oils, shale oils, tars, greases and mixtures of powdered coal, oil and water. Address F. G. Cottrell, Director, Bureau of Mines, Washington, D. C.

Glass and Ceramics A3–20. Colloidal Kaolin. The Kraus process for the treatment of kaolin is based on the colloidal theory in which colloidal gels already existent but confined or imprisoned by waters of crystallization are released and remaining constituent crystalline and amorphous bodies are partially gelatinized. The colloidal gels are predominant after treatment and there is a change in plasticity, absorption, covering capacity, bonding strength and burning density. There is much improvement in the manufacture of many products. Greater retention is shown when used as a paper filler; china ware is more translucent; paint more adhesive and of greater covering capacity; electric porcelain has higher dielectric strength; oilcloth is more flexible. Colloidal kaolin is made adaptable for new uses as in soap, glass pots, refractories and it may replace silica in steel manufacture. Address Kraus Research Laboratories, Inc., 130 Pearl St., New York.

Glass and Ceramics A4–20. Ultramicroscopic Examination of Clays. A study of clays by ultramicroscopic examination indicates that a study along the lines of colloid-chemical principles and analysis will throw much light upon many obscure phenomena met by those who use clay for ceramic and other purposes. See article by Jerome Alexander in the *Journal of the American Ceramic Society*, August 1920.

Internal-Combustion Motors A3–20. Preheating Air Fuels. A paper was presented at the June Meeting of the Society of Automotive Engineers by a member of the staff of the Bureau of Standards giving a report on the value of various systems in preheating air fuel used in automobile engines. This work is being continued to ascertain the effect of different degrees of heating. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Machine Shop A1–20. Calibration of End Standards. The Bureau of Standards is using interference methods for the calibration of end standards used as precision gages and is obtaining rapid and reliable work and increasing the production of high-precision end standards. An article on this method of calibration is being prepared for publication. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Machine Design A2–20. Shrink Fits. Experiments to determine allowance for locomotive reverse shaft arms with bearings 4 in. in diameter and 4 in. long. Ordinary shop practice allows $^{1}/_{64}$ in. for all sizes and styles. Steel specimens prepared in form of round disks 4 in. indiameter and 4 in. thick. Steel collars $^{7}/_{8}$ in. thick were machined with holes bored smaller than 4 in. by the following amounts: 0.004 in., 0.008 in., 0.012 in., 0.016 in., 0.020 in. These numbers vary by 0.001 in. per inch of diameter. The collars were shrunk on at a temperature of 600 deg. fahr. and in accordance with common practice, and after cooling, the sleeve was supported by a sleeve with a $4^{1}/_{2}$-in. hole, while a plug of smaller diameter than 4 in. was placed on the 4-in. disk. After this load was applied from a testing machine to determine the starting pressure and the pressure at each quarter inch. The results of the test are shown by the curve, Fig. 1. The maximum strength seems to occur at about 0.00375 in. per inch of diameter. This result is about the same as that found for axles and wristpins of this size and the same allowance will be made for shrink fits of steel as had formerly been used for forced fits of steel, the latter being the result of careful tests. Address H. V. Wille, Baldwin Locomotive Works, Philadelphia, Pa.

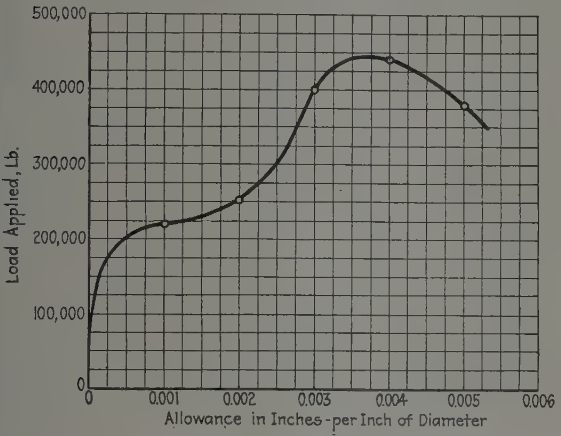

Fig. 1 Shrink Fits: Curve of Starting Pressure

Mining, General A5–20. Preserving Mine Timbers. The Forest Products Laboratory installed timbers treated with coal-tar creosote in an Alabama mine ten years ago. During this time all untreated timbers have been removed on account of decay, while 80 per cent of the creosoted timbers are still sound and none have decayed to an extent requiring removal. Other experiments have proved the same thing. Three preservatives are suitable for mine work: coal-tar creosote; zinc chloride, and sodium fluoride. The first of these is the most effective. The fire hazard as shown from long experience is not greatly increased by the use of creosote. Zinc chloride and sodium fluoride are odorless and tend to reduce inflammability. They are cheaper but do not give such permanent protection. Creosote is applied by brush, dipping or by pressure. Zinc chloride and sodium fluoride may be injected by steeping or by pressure. The saving will pay in every case. The wood preservative should be soluble in water if made from inorganic salts. In this way the poisonous substance is carried into the wood. In the case of creosote the poisonous material is carried in the oil. Address Director, Forest Products Laboratory, Madison, Wis.

Reflectometer A1–20. Reflectometer. See *Apparatus and Instruments A16–20.*

Refrigeration A4–20. Methyl Chloride. A pamphlet describing the properties and uses of methyl chloride has been issued by the Roessler & Hasslacher Chemical Company. This pamphlet gives a historical sketch of its discovery, manufacture and use, its physical properties, its chemical and physiological properties, its purity and its application as a refrigerant. Address The Roessler & Hasslacher Chemical Company, 709 Sixth Ave., New York.

Textile Manufacture and Clothing A1–20. Bleaching. Articles in the *Textile World Journal* by Allen Abrams and in *Cotton* by J. Merritt Matthews discuss the use of electrolytic bleaching as compared with the use of lime. In both papers the electrolytic bleach is shown to be more convenient to make, more uniform, less liable to change under storage, less expensive, more rapid, better controlled and the cloth bleached with the electrolytic liquors is more easily freed from residual chlorine and other materials than that bleached with bleaching powders. The tensile strength of the goods does not vary in the two methods of treatment.

Wood Products A9–20. Wood Preservation. The Forest Products Laboratory has investigated the possibility of protecting wood by charring. The area of charred wood does not decay or encourage the growth of fungi. This layer, however, is broken in places by checks and infection can enter through these cracks. If charring is deep enough to resist decay the post is weakened. The laboratory has shown that mine timbers could be properly protected by coal-tar creosote, zinc chloride or sodium fluoride when properly impregnated. Address Director, Forest Products Laboratory, Madison, Wis.

B—Research Problems

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Automotive Vehicles and Equipment B4–20. Fan Belts. An investigation to determine the performance of fan belts by using a motor and a typical automobile fan. Revolution counter attached to fan pulley and motor will give slippage. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Automotive Vehicles and Equipment B5–20. International Harvester Co. The Laboratory No. 5 of the Experimental Department of the International Harvester Company is investigating brake lining, clutch facing and fan belting as well as belts, pulleys, pulley coverings and chains. It is making absorption tests on all apparatus and parts of tractors, trucks and stationary engines. Address O. B. Zimmermann, Experimental Department, International Harvester Co., 606 South Michigan Ave., Chicago, Ill.

Electric Power B3–20. Farm Lighting. Laboratory No. 5 of the Experimental Department of the International Harvester Co. is investigating storage batteries for the purpose of determining the best type for farm lighting purposes and also the form of electric generator for the same purpose for variation of speed of 600 per cent. Address O. B. Zimmermann, Experimental Department, International Harvester Co., 606 South Michigan Avenue, Chicago, Ill.

Glass and Ceramics B4–20. Coal-Gas Retorts. Investigation of the thermal qualities, strength and the other properties of gas retorts. Address Kalmus, Comstock & Westcott, Inc., 110 Brookline Ave., Boston, Mass.

Glass and Ceramics B5–20. Glazes. An attempt is being made to differentiate the various glazes applied to clay products by a machine similar to that of Brinell. The steel sphere is replaced by a conical steel point. Penetration is being measured by a micrometer microscope. The pressures are quite high. A study on high-fire porcelain glazes has shown that the range of compositions suitable for high fire increases rapidly with the temperature. Low-silica glazes are found to overfire at temperatures corresponding to cone No. 12. The limits for glazes of temperatures up to cone No. 16 have been established quite definitely. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Glass and Ceramics B6–20. Refractories for By-Product Coke Ovens. A study of the properties of a new silica refractory suggested research for by-product coke-oven refractories, considering the effect of carbonic acid gas, the abrasive action of charge; cooling effect; strength of product in cross-breaking and load; testing under heat and the thermal qualities of the refractory employed. This latter points to the advantage in using special refractory material which develops greater efficiency by reducing the time of coking of charge, quantity of gas used in coking, and permitting radical decrease in the temperature of the combustion of the gas. Address Kalmus, Comstock & Westcott, 110 Brookline Ave., Boston, Mass.

Internal-Combustion Motors B1–20. International Harvester Co. The following investigations are being undertaken by the Laboratory No. 5 of the International Harvester Company:

1 The development of the intake manifolds for tractor engines using kerosene.
2 The increased temperature of the ingoing mixtures produced by the new hot-spot manifolds increases the average temperature of the gases in the cylinders, which affects heat losses to the cylinder and affects valves, spark plugs, etc.
3 Carburetors and mixers for properly metering fuel to vaporizing chambers.
4 Fuel investigations.
5 Air cleaners, their efficiency in cleaning and possible causes for loss of volumetric efficiency in engines.
6 Proper vaporizers, spraying nozzles and metering pumps for high-compression and semi-Diesel oil engines.
7 The Hvid engine's characteristics and durability.
8 General stationary-engine development.
9 Continuous-combustion-engine developments such as pumps, refractories, proper valve timing, and compression problems in connection with the power cylinder.
10 Overheating problems of engines using kerosene.
11 Proper valve areas consistent with the increased temperature of the mixtures for proper vaporization.
12 Automatic and auxiliary intake valve-spring determination for proper spring design.
13 Governor investigations.
14 Radiator problems concerning trucks and tractors.
15 The proper use of anti-friction bearings for crankshafts and their durability.
16 Durability tests on all engine parts to determine proper design.
17 The action of greases on gears in regard to wear, lubrication and power absorbed.

18 Proper methods and procedure for determining proper lubricating oils for internal-combustion engines.

19 Placing of spark plugs and proper materials of construction for use in heavy-duty kerosene-burning engines.

Metallurgy and Metallography B15–20. Decarburization of Steel in Vacuum. A study is being made of steels in vacuo when heated above the A_1 point for different periods. The metal loses carbon on the surface, the amount being proportional to the time of heating. The carbon seems to leave as a gas, probably carbon monoxide. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Steam Power B4–20. Unified-Power Plants. Laboratory No. 5 of the Experimental Department of the International Harvester Co. is at work on the development of the unified system of burners, boilers, condensers, pumps and controls for steam power plants. Address O. B. Zimmermann, Experimental Department, International Harvester Co., 606 South Michigan Ave., Chicago, Ill.

Steam Power B5–20. Condenser Tubes. An investigation is being made by the General Electric Company, of Schenectady, and the Diamond Power Specialty Company, of Detroit, on the life of condenser tubes. The investigation is undertaken to determine the possibility of utilizing calorized copper tubes for condensers. Calorizing has proven its value in preventing oxidation of soot-blower units, pyrometer protection tubes and other equipment. It is not known that calorizing has been utilized successfully as a means for preventing corrosion. Information is desired from power plants and marine engineers respecting the service obtained from condenser tubes, and this coöperation is requested. The communication should state the metal of which tubes are made, size and lengths of tubes and life of tubes. Address Robert June, Diamond Power Specialty Company, Detroit, Mich.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Machine Design C3–20. Ball Bearings at High Speeds. The reference to this subject under *Machine Design C2–20* arose from the discussion that as the speed of the ball was increased very materially the centrifugal force became very great, and in such cases large balls are improper because the mass causing centrifugal forces will vary as the cube of the diameter of the ball, while its bearing power will only increase as the diameter. This will mean centrifugal troubles at high speeds. Inquiry is made on this subject. Has any one studied this particular problem or made experiments which would answer questions arising in this study? Address Panfilo Trombetta, General Electric Company, Schenectady, N. Y.

Steam Power C1–20. Condenser Tubes. (See *Steam Power B5–20.*) In this investigation on corrosion of condenser tubes and its prevention, coöperation is asked from engineers of power plants and marine equipment regarding (*a*) metal used for condenser tubes, (*b*) size and lengths of tube and (*c*) life of tubes. Any data will be greatly appreciated for this research. Address Robert June, Diamond Power Specialty Company, Detroit, Mich.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Henry Souther Engineering Company D1–20. Metallurgical Laboratory. The equipment of the Henry Souther Engineering Company devoted to metallurgical and sanitary inspection consists of a chemical laboratory equipped to handle routine metallurgical analysis; organic laboratory equipped to handle materials and compounds such as oils, greases, paints, boiler waters and plating compounds. A physical testing laboratory for tensile, transverse and compression tests, hardness machines, impact testers and fatigue testers. The metallurgical laboratory is equipped for practical heat treatment and metallographic studies of steel, iron, brass, bronze and other alloys. Address Henry Souther Engineering Company, 11 Laurel St., Hartford, Conn.

Hydraulics D1–20. Hydraulic Laboratory at Purdue University. See *Purdue University D1–20.*

Kalmus, Comstock & Westcott, Inc. D1–20. Laboratory for Industrial Research in Ceramics. Laboratory is housed in reinforced-concrete building with water, 110- and 220-volt d.c. current and gas. All power electrical. Especially equipped for refractories and refractory materials.

Equipment:

Muffle furnace, gas- and oil-fired for temperatures up to 1400 deg. cent., atmospheric conditions under control.

Circular pit furnace, gas-fired for temperatures of 1450 to 1500 deg. Load capacity, 6000 lb.

Cross-breaking and compression testing machines.

Leeds & Northrup two-point recording thermometer for base-metal and noble-metal samples.

Special thermal-conductivity-determining apparatus designed and developed at laboratory. Accurate determinations on refractory and insulating materials at 100 to 1000 deg. cent. Apparatus specially designed to guard against side loss.

Small electric muffle furnace for 1000 deg. cent.

36-in. surface grinder, jaw crushers, pulverizers, mixers, driers, air compressors, fans.

Kilns available for standard and special operating conditions.

Address Kalmus, Comstock and Westcott, Inc., 110 Brookline Ave., Boston, Mass.

Minneapolis Steel & Machinery Company D1–20. Metallurgical Laboratory. This laboratory is equipped for physical, metallographical and chemical work. Address C. S. Moody, Metallurgical Engineer, Minneapolis Steel & Machinery Company, Minneapolis, Minn.

Purdue University D1–20. Hydraulic Laboratory. The laboratory established in 1911 has a maximum flow of 8400 gal. per min. at 34 ft. and 1800 gal. per min. at 231 ft. This is produced by pumping. The equipment is as follows:

(*a*) One Platt direct-driven single-stage centrifugal pump with a capacity of 8400 g.p.m. against a maximum head of 34 ft.

(*b*) One American two-stage direct-driven centrifugal pump with a capacity of 1800 g.p.m. against a maximum head of 231 ft.

(*c*) One Allis-Chalmers direct-driven single-stage centrifugal pump with a capacity of 400 g.p.m. against a maximum head of 116 ft. The motor is of the d.c. variable-speed type.

(*d*) One Gould triplex pump with a capacity of 60 g.p.m.

(*e*) One 2-in. rotary pump.

(*f*) One Trump 12-in. reaction turbine.

(*g*) One Fairbanks weighing scales of 20 tons capacity. The balance arm of the scale is equipped with an electric timing device.

(*h*) One concrete channel, 3 ft. wide, 3 ft. deep, and 80 ft. long, supplied with track and carriage for current-meter investigations.

(*i*) One large concrete channel, 6 ft. deep and 70 ft. long composed of two sections, one 8 ft. and the other 5 ft. in width. Each section is equipped with a rectangular weir. The flow from the channel passes into the large weighing tank.

The laboratory is 115 ft. by 50 ft. with a main floor and gallery. A concrete reservoir of 82,000 gal. capacity is situated under the main floor. In addition to the apparatus listed above there are a number of small tanks and scales, small impulse wheels, hydraulic ram, orifices, weirs, tubes and water meters. A movable equipment for pitot tubes and current meters up to a maximum range of 5 ft. per sec. is available. The laboratory is in charge of F. W. Greve. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

The Westport Mill D1–20. Chemical Laboratory. Laboratory for chemical and hydrometallurgical work. The laboratory devoted to determining the proper size of Dorr equipments for the Dorr Company, Engineers, New York, Denver and London. Laboratory is equipped for researches dealing with the separation of solutions from finely divided solid substances often of colloidal nature. Purification and preparation of clays and the continuous production of finely ground pigments. Address J. A. Baker, Westport Mill, Westport, Conn.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession and especially the members of the A.S.M.E. of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on approval of the Research Committee. After these bibliographies are prepared they are loaned to the person requesting them for a period of one month. Additional copies are prepared which are available for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society which is probably the largest Engineering Library in this country.

Fuels, Gas, Tar and Coke F7–20. Kerosene and Carburation. A bibliography of $2^{1}/_{2}$ pages. Search 3117. Address A.S.M.E., 29 West 39th St., New York.

Pumps F1–20. Jet Apparatus, Injectors and Ejectors. A bibliography of 3 pages. Search 3126. Address A.S.M.E., 29 West 39th St., New York.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

THE procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the Interpretations of the Committee in Cases Nos. 259, 285, 305, 307, 310, 314–317, inclusive, as formulated at the meeting September 24, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 259 (Reopened)

Inquiry: Is it allowable, under the requirements of the A.S.M.E. Boiler Code, to fit a high-pressure steam boiler with a blow-off connection larger than $2^{1}/_{2}$-in. in case it is to be used initially for low-pressure steam or hot-water heating, or will it be necessary under the requirements of Par. 308 to apply two or more $2^{1}/_{2}$-in. blow-off connections for the return connections to the boiler?

Reply: It is the opinion of the Committee that a boiler could be initially fitted with a blow-off connection larger than $2^{1}/_{2}$-in. size when intended for use as a steam or hot-water heating boiler, and when converted to a steam boiler if to operate at over 15 lb. pressure, but not exceeding 100 lb. pressure, a reducing fitting could be used at the opening to reduce to the pipe size required for the blow-off connections by Par. 308.

CASE NO. 285 (Reopened)

Inquiry: Is is permissible, under the rules of the Boiler Code, to use standard extra-heavy cast-iron flanges and fittings on pipe connections between boilers and attached-type superheaters, and on the ends of superheater inlet headers for pressures up to 250 lb. per sq. in.? It is pointed out that neither the inlet pipe connections nor the superheater inlet flanges would be subjected to other than saturated steam temperatures.

Reply: It is the opinion of the Committee that the flanges and fittings referred to may be made of cast iron, provided the temperature of the steam does not exceed 450 deg. fahr. as specified in Par. 12.

CASE NO. 305

Inquiry: Is it permissible, under the requirements of the Boiler Code, to connect sections of wrought-steel headers, one of which is shrunk or forced over the end of the other, making a close fit and secured by means of bolts of ample cross-sectional area, the joint being calked or autogenously welded to insure tightness, the design of the joint to be such that it will be of ample strength, neglecting the holding power due to shrinking or forcing one section over the other and the holding power of the autogenous welding?

Reply: It is the opinion of the Committee that while the construction described is not a desirable one, it is not prohibited by the Code.

CASE NO. 307 (Reopened)

Inquiry: Is it permissible to so locate the supporting lugs on h.r.t. boilers where more than four lugs are required and unde Par. 323 of the Code, must be set in pairs, that those in each pair come close together, or must the horizontal distance between the center lines of rivets attaching the adjacent lugs to the shell be at least equal to the vertical spacing of rivets that is required for lug attachments in Par. 323, as shown in Fig. 8?

Reply: There is no requirement in the Code specifying the distance apart of the lugs forming pairs as required by the last sentence of Par. 323. It is the intent of the Boiler Code that the distance between the lugs should be such as to give at least $^{1}/_{2}$ in. between the edges of the lugs and not more than 2 in. The load should be equalized between the two lugs.

CASE NO. 310

Inquiry: *a* Can a type of boiler other than the h.r.t. type have lap joints where the courses are over 12 ft. long?

b With butt and double strap construction on longitudinal joints for boilers other than of the h.r.t. type, is it required that the tension test specimens be cut from the shell plate as provided in Par. 190?

Reply: *a* The restriction in length of lap joints to 12 ft. in Par. 190 of the Boiler Code applies specifically to boilers of the h.r.t. type, and there is nothing in the rule which prohibits the construction of shells and drums of lengths exceeding 12 ft. for other types of boilers.

b Inasmuch as the first sentence of Par. 190 applies specifically to h.r.t. boilers, as pointed out in reply (*a*), it is the opinion of the Committee that this prohibition does not cover other types of boilers.

CASE NO. 314

Inquiry: Is it the opinion of the Boiler Code Committee that a lap joint reinforced with a cover plate should be considered as an ordinary lap joint and the requirements for factors of safety given in Pars. 379 and 380 applied accordingly?

Reply: It is the opinion of the Committee that a lap joint even though reinforced by a cover plate, should be treated exactly the same as the simple form of lap joint, so that the factors of safety proposed in Pars. 379 and 380 for lap joints would be applicable.

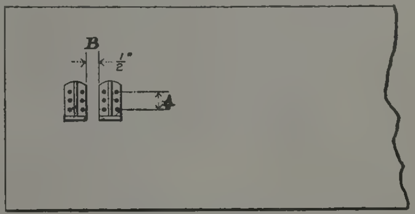

FIG. 8 SPACING OF SUPPORTING LUGS IN PAIRS ON H.R.T. BOILERS

CASE NO. 315

Inquiry: Is it to be understood that the requirements of Par. 323 of the Boiler Code, relative to the location of lugs and the distribution of rivets attaching them to the shell, apply to the small sizes of boilers referred to in Par. 324?

Reply: The requirements of Par. 323 of the Code are clearly limited to h.r.t. boilers over 78 in. in diameter. It will be found that Par. 325 gives the requirements for attaching the lugs.

CASE NO. 316

Inquiry: Is it permissible, under the requirements of the Boiler Code, for a boiler manufacturer to stamp a boiler as A.S.M.E. Code Standard, when it is fitted with a safety-valve nozzle or connection that is adequate only for safety valves operating at high lifts?

Reply: The way designated in the Code in which the size of the safety valve or valves that shall be used on any boiler is determined, is by their relieving capacity, and where the safety-valve opening corresponds to that required from such a valve or valves, the boiler is constructed in accordance with the A.S.M.E. Code in this respect, and may be so stamped. The Committee suggests, however, that where boilers are sold for a given operating pressure without knowledge of the type of safety valves that will be used, the safety-valve openings be proportioned for the intermediate lifts and corresponding relieving capacities given in Table 15 of the Code.

Case No. 317

Inquiry: If it is permissible, as indicated in Case No. 298, to fit a steam outlet nozzle with a wrought-steel flange screwed to the outer end of the end neck to which the flange is threaded and peened over into a beveled part cut away from the flange, why should not this construction be acceptable for the fastening of the flange at the other end of the nozzle for attachment to the boiler shell?

Reply: It is the opinion of the Committee that this construction does not conform to the requirement of the last sentence in Par. 268.

Data Sheets of the Interpretations of the Boiler Code

As a result of the widespread demand from the steam-boiler field the Boiler Code Committee has inaugurated the practice of reprinting from Mechanical Engineering the Interpretations issued at its regular monthly meetings and approved by the Council, and these are now available for general distribution in data-sheet form, trimmed to convenient size and punched for insertion in suitable binders. These data sheets begin with Case No. 200, which is the first Case formulated by the Boiler Code Committee in interpretations of the 1918 edition of the Code; the Cases from Nos. 1–199 have not been reprinted in this form, as with their incorporation in the new edition of the Boiler Code (edition of 1918) they are superseded and thus rendered of no further service.

These data sheets are available upon application to the office of the Secretary of the Boiler Code Committee, at the prevailing rates charged by the Publication Committee for reprinted matter. They may be obtained singly or in complete sets from Case No. 200 up, as may be desired. Should it be desired to preserve them in a convenient form, this may be accomplished by ordering in addition, a boiler code binder, this being fitted with clamping bolts for binding in not only the data sheets but also the Boiler Code, if desired.

In response to numerous calls that have been received fer copies of these Interpretation data sheets as issued, preparations have been made for supplying them on regular subscriptions as often as issued where ordered in advance. Further information concerning the terms of such subscriptions will be given upon application to the Secretary's office.

Promulgation of the Boiler Code

The American Uniform Boiler-Law Society, organized primarily to secure the legal adoption of the A.S.M.E. Boiler Code, has at the same time used its office to disseminate information and news about the Code.

For example, the society has made a survey of the educational institutions and reports that the following are using the Code as a textbook:

Massachusetts Institute of Technology
Sheffield Scientific School
Yale University
Armour Institute of Technology
Case School of Applied Science
University of Vermont
University of Cincinnati
Johns Hopkins University
University of Michigan
University of Minnesota
Rensselaer Polytechnic Institute

Rutgers College and University of Texas, beginning this year, will also use the Code as a textbook.

The following institutions are using the Code as a reference book:

Vanderbilt University (Tennessee)
New Mexico College of Agriculture and Mechanic Arts
Tulane University of Louisiana
University of Colorado
University of Washington
University of Maine
University of Wyoming
Virginia Polytechnic Institute
Washington University (St Louis)

This survey shows that the Code is having a greater sphere of usefulness than was ever anticipated.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Code of Ethics Restated

To the Editor:

The following is a restatement of the Proposed Code of Ethics which was published in the September issue of Mechanical Engineering.[1]

In order to remain in good standing in The American Society of Mechanical Engineers a member in any of the grades of the Society shall observe the following rules of conduct:

1 He shall not fail to recognize that the first duty of an engineer is to be a useful citizen, exemplifying in his character and his practice the highest ideals of citizenship and of loyalty to his country.

2 He shall not permit selfish considerations to influence his professional conduct, but shall ever recognize service to society and the public as fundamental in promoting the interests of the engineering profession.

3 He shall not associate himself with any questionable or illegitimate enterprise and shall not countenance such association by a fellow-engineer, but shall endeavor to prevent it, first by friendly counsel and, that failing, by reporting the facts and circumstances to the proper authorities.

4 He shall not accept compensation, pecuniary or otherwise, from more than one interested party and shall not receive, directly or indirectly, any royalty, gratuity, or commission on any patented article or process used in the work upon which he is retained, without the knowledge and consent of all interested parties.

5 He shall not undertake any engineering work in which his judgment or the character of his services might be influenced by his other connections or interests, and he shall not allow his clients' or employers' interests to suffer in any way through his professional relations with others.

6 He shall not knowingly compete with a fellow-engineer in the matter of professional charges, or attempt to supplant him after definite steps have been taken toward his employment; and he shall not take over the work of another consulting engineer without first conferring with him and becoming satisfied that ample reasons exist for a change.

7 He shall not advertise in an undignified, sensational or misleading manner or solicit work by dishonest or unseemly methods; and he shall not countenance sensational, exaggerated or unwarranted statements about his own work in the public press; but may publish to the technical world new inventions, processes, and engineering projects and accomplishments through the engineering societies and the technical press in preference to the public press.

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[1] Section Two, p. 123.

8 He shall not misrepresent recognized facts and well-established theories in making reports, or in testifying as an expert; and he shall not confuse newly discovered facts and newly evolved theories with those that have been long accepted; and he shall not jeopardize the good name of the profession by public expression of opinions as an engineer on subjects in which he may not properly qualify as an authority.

9 He shall not make public any information obtained from or through work for a client or employer, nor shall he at any time make such use of it as will embarrass the client or employer in whose service it was obtained, but may use such information as forming part of his professional experience to guide in his own professional practice.

10 He shall not refuse to help his fellow-engineers, by exchange of general information and experience, by personal interest in their welfare or by instruction through engineering societies, schools of applied science, and the technical press, or through the public press under conditions that will insure accuracy and guarantee that such public instruction shall not mislead.

Ann Arbor, Mich. M. E. COOLEY.

Economy of Passenger Automobiles at Various Speeds

TO THE EDITOR:

The limited supply of fuel for automobiles makes it imperative that the cars be run with the minimum amount of gasoline. It is a duty of every owner of a car to save the fuel, not only because it benefits his own pocketbook, but also because it makes more fuel available for the whole nation.

There are certain speeds at which it is most advantageous and economical to run a car, and those who drive automobiles should be requested to coöperate in saving gasoline by driving their cars as closely as possible at these speeds.

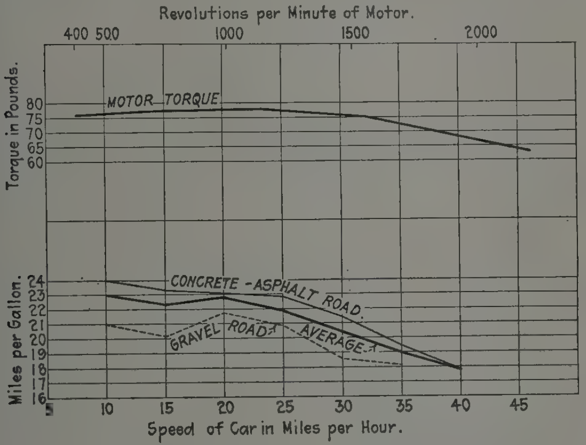

FIG. 1 MILES PER GALLON OF GASOLINE AND MOTOR TORQUE, DORT CAR Motor, 4-cylinder; bore, $3^1/_2$ in.; stroke, 5 in.; gear ratio, 4.25 to 1; tires, 30 in. by $3^1/_2$ in.; car weight, 2400 lb.

In order to establish the most economical speed for the average automobile, the author has made some very complete and thorough experiments at speeds of 10, 15, 20, 25, 30, 35 and 40 m.p.h.

These tests were made on concrete roads and gravel roads and in the directions north, south, east and west, in order to offset the effect of the wind, which has a marked influence in increasing or decreasing the consumption of gasoline according to whether the automobile travels with or against it. The car used was a Dort car, with a four-cylinder motor, having a $3^1/_2$-in. bore and 5-in. stroke. The weight of the car is 2400 lb. in running order. The size of the tires is 30 by $3^1/_2$ in. The gear ratio on the rear axle is $4^1/_4$ to 1. The load carried corresponded to a three-passenger load, and the top was up with the windshield closed.

The results of these tests are given in Table 1, and show the average gasoline consumption for each speed in the four directions of the compass. In Fig. 1 the tests are condensed into a single average and a curve is drawn which shows at a glance the most economical speed of the car.

TABLE 1 ECONOMY OF LIGHT CAR AT VARIOUS SPEEDS

4 cyl. motor, $3^1/_2$-in. bore, 5-in. stroke; gear ratio, 4.25 to 1; wheels, 30 in. by $3^1/_2$ in.; car weight, 2400 lb.; 3 passengers.

Miles per hr.	Road	Direction	Temp. deg. fahr.	Weather	Date	Miles per gal.
10	Concrete	South	80	Clear	Sept. 8/20	23.6
10	Concrete	North	80	Clear	Sept. 8/20	25.6
10	Concrete	South	80	Clear	Sept 8/20	21.2
10	Concrete	North	80	Clear	Sept. 8/20	25.6
10	Gravel	West	75	Cloudy	Sept. 9/20	21.4
10	Gravel	East	75	Cloudy	Sept. 9/20	20.6
					Average,	23.0
15	Concrete	South	75	Clear	Sept. 3/20	23.2
15	$^2/_3$ concrete, $^1/_3$ sand	South	75	Clear	Sept. 3/20	22.4
15	$^2/_3$ concrete, $^1/_3$ sand	North	75	Clear	Sept. 3/20	24.0
15	Concrete	North	75	Clear	Sept. 3/20	25.2
15	$^2/_3$ concrete, $^1/_3$ gravel	East	75	Clear	Sept. 3/20	25.4
15	$^2/_3$ concrete, $^1/_3$ gravel	West	75	Clear	Sept. 3/20	24.4
15	Dry gravel	West and south	75	Clear	Sept. 3/20	21.6
15	Loose gravel	East	75	Clear	Sept. 3/20	18.0
15	Loose gravel	West	75	Clear	Sept. 3/20	19.4
15	Concrete	South	80	Clear	Sept. 8/20	21.2
15	Concrete	North	80	Clear	Sept. 8/20	23.6
15	Wet gravel	West	75	Cloudy	Sept. 9/20	21.2
15	Wet gravel	East	75	Cloudy	Sept. 9/20	20.4
					Average,	22.3
20	Concrete	South	75	Clear	Sept. 3/20	21.8
20	Concrete	North	75	Clear	Sept. 3/20	22.4
20	Concrete	South	80	Clear	Sept. 8/20	21.8
20	Concrete	North	80	Clear	Sept. 8/20	24.8
20	Wet gravel	West	75	Cloudy	Sept. 9/20	22.8
20	Wet gravel	East	75	Cloudy	Sept. 9/20	20.8
20	Wet concrete	North	75	Cloudy	Sept. 9/20	23.6
20	Wet concrete	South	75	Cloudy	Sept. 9/20	22.6
20	Concrete	South	75	Clear	Sept. 13/20	23.0
20	Concrete	North	75	Clear	Sept. 13/20	25.0
					Average,	22.86
25	Concrete	South	75	Clear	Sept. 4/20	24.4
25	Concrete	North	75	Clear	Sept. 4/20	22.4
25	Concrete	East	80	Clear	July 1/20	22.0
25	$^1/_2$ gravel, $^1/_2$ concrete	North	80	Clear	July 1/20	23.2
25	Concrete	South	80	Clear	Sept. 8/20	21.0
25	Concrete	North	80	Clear	Sept. 8/20	24.0
25	Dry gravel	West	70	Clear	Sept. 13/20	20.4
25	Dry gravel	East	70	Clear	Sept. 13/20	21.2
25	$^1/_2$ gravel, $^1/_2$ concrete	East and north	70	Clear	Sept. 13/20	21.2
25	$^1/_2$ gravel, $^1/_2$ concrete	South and west	70	Clear	Sept. 13/20	18.8
					Average,	21.86
30	Concrete	North	80	Clear	July 1/20	24.0
30	Concrete	South	80	Clear	July 1/20	20.4
30	Concrete	South	75	Clear	Sept. 4/20	20.4
30	Concrete	North	75	Clear	Sept. 4/20	21.0
30	Concrete	South	75	Cloudy	Sept. 9/20	20.0
30	Concrete	North	75	Cloudy	Sept. 9/20	24.4
30	Dry gravel	West	70	Clear	Sept. 13/20	19.0
30	Dry gravel	East	70	Clear	Sept. 13/20	20.8
30	Concrete	North	70	Clear	Sept. 13/20	20.0
30	Dry gravel	West	70	Clear	Sept. 13/20	17.6
30	Dry gravel	East	70	Clear	Sept. 13/20	16.8
					Average,	20.4
35	Concrete	South	75	Clear	Sept. 4/20	18.0
35	Concrete	North	75	Clear	Sept. 4/20	19.6
35	Concrete	South	75	Clear	Sept. 9/20	18.4
35	Concrete	North	75	Clear	Sept. 9/20	22.0
35	Dry gravel	West	70	Clear	Sept. 13/20	17.4
35	Dry gravel	East	70	Clear	Sept. 13/20	19.0
					Average,	19.06
40	Concrete	South	75	Cloudy	Sept. 11/20	16.0
40	Concrete	North	75	Cloudy	Sept. 11/20	19.6
					Average,	17.8

A curve of the motor torque is plotted above the economy curve in Fig. 1, and an examination of these curves will show that the economy curve follows the torque curve very closely, with a tendency for the former to fall faster above 25 m.p.h., due to the increased wind resistance. It would seem logical, therefore, in order to get the greatest possible economy out of the cars, to lower the gear ratio in the rear axle, thereby reducing the engine speed, or else to have a geared-up fourth speed in the transmission.

It is to be noted that after a speed of 25 m.p.h. is reached the economy curve falls down very fast; therefore it would be to the interest of car owners to drive their vehicles at a speed not exceeding 30 m.p.h. in order to get the best results. A speed of approximately 30 m.p.h. is about the maximum speed at which a car can be driven with safety on our present roads. Of course, it is almost impossible to establish arbitrarily a limit of 30 m.p.h. for the maximum speed of an automobile, as the engineer must take into account the poor roads which are encountered in various parts of the country, where more power is needed to pull the car through, but a car with a maximum possible speed of 40 m.p.h. on good roads would have enough power to go anywhere.

The tests show very plainly that a concrete-asphalt road gives a much better mileage than the ordinary gravel road or the sandy road, and consequently, as the building of good hard roads progresses throughout the country, the economy in gas consumption will become greater.

If these different facts are given wide publicity, not only by the oil industry but by the automotive industry and the public press, it will show to the governments of the states, and to the Federal Government, that the sooner we build up a smooth, solid type of highways all through the country, the quicker will we get better mileage in the operation of motor cars and motor trucks, and the conservation of our natural resources in oil will be greatly enhanced.

Certain emphasis has been laid on the fact that the automotive manufacturers ought to build lighter cars, which would give the necessary comfort with less waste of gas. A number of manufacturers are already producing such cars; but the majority of cars on the market in the light-weight class are great wasters of gasoline as they average only between 15 and 16 miles to the gallon, due to their very inefficient motors.

From the author's experience, a car with a weight not to exceed 2000 lb. in running order, without passengers, should give easily 25 to 30 miles to the gallon; a car weighing between 2000 and 2500 lb. under the same conditions should give, easily, between 20 and 25 miles per gallon; and the heavier cars up to 3000 lb. weight should give 16 to 20 miles to the gallon, without any question. However, the efficiency of the motor alone is not all that is necessary to obtain these figures. The car should be kept in good order, with the brake drums free from dragging brakes, tires should be inflated to their proper pressure, and the lubrication of the complete car well taken care of in order to get the maximum efficiency.

These different points will be brought to the front more and more as the number of automobiles increases and it becomes imperative to use less gasoline per automobile in order to have enough for everybody. E. Planche.

Flint, Mich.

Effect of Radial Play on Life of Ball Bearings

To the Editor:

Tests have recently been made by the Fafnir Bearing Company to determine the effect of radial play on the life of ball bearings which it may be of interest to report. By radial play is meant the amount of shake or looseness between the inner and outer rings in a direction at right angles to the bore. This play is measured after the bearing is completely assembled ready for shipment, and by the use of a special gage employed in the inspection of Fafnir bearings.

Most users of ball bearings demand that the radial play be very small, some specifying that it shall not exceed 0.001 in. They consider it sufficient that a bearing should run freely before being mounted and that no perceptible play exist.

At first one would believe that the less play the better, as long as the bearing is free to turn. One must consider, however, that the examination or inspection of ball bearings is made before mounting and that the mountings call for a drive fit of the inner ring over the shaft, and sometimes the outer ring is also forced into its housing. Several tests were made to determine what effect this forcing of the bearings into place had. It was found that inner rings expanded from 0.0003 to 0.0004 in., and outer rings contracted from 0.0002 to 0.0003 in., these measurements being made when press fits were used.

These facts make it apparent that the radial play must be considered after the bearing has been mounted. It is of course impossible in most installations to measure radial play after the bearing is mounted, but it is quite possible to measure the expansion and contraction of inner and outer rings. When an average value has been established for these two items, the problem is simplified. For instance, consider a bearing having a play of 0.0005 in. before mounting, and a mounting that causes an expansion of 0.0002 in. of the inner ring and a contraction of 0.0001 in. of the outer ring. The radial play after mounting will be the sum of the expansion plus the contraction (0.0001 + 0.0002 = 0.0003) subtracted from the play before mounting (0.0005 — 0.0003 = 0.0002). Hence the radial play after mounting is very different from that in the unmounted bearing.

It is quite evident that under certain conditions the bearing may be loose enough to turn easily before mounting and may be entirely too tight afterward. In order to determine whether or not a tight bearing wears out faster than a loose one a series of tests was made, the results of which are tabulated below. It must be remembered that the radial play of these test bearings was measured before mounting in the test block. The test mounting reduced the play in each case by about 0.0002 in.

Bearing No.	—Radial Play, Inches—		Hr. Run	Remarks
	Before Mounting	After Mounting		
1	0.0000	Cramped	347	Failed at this time
2	0.0000	Cramped	477	
3	0.0002	0.0000	323	
4	0.0002	0.0000	477	
5	0.0004	0.0002	571	No signs of failure
6	0.0008	0.0006	803	
7	0.0012	0.0010	571	
8	0.0012	0.0010	585	

These results indicate that the play should be at least 0.0005 in. after mounting. The necessary play before mounting must be determined for each condition of installation. This must be done by the user under average conditions as he finds them.

In conclusion, it may be well to point out that there is a slight variation of play in all bearings. This is due to the fact that a slight tolerance or variation must be permitted to make bearing manufacture commercially possible. This variation in radial play is usually about 0.0005 in. but for large bearings may exceed this. Thus a specification should read that the radial play must in no case be less than a certain amount. This amount is determined from the known expansion and contraction of the rings as pointed out above. Roland W. Sellew.

New Britain, Conn.

ORGANIZATION AND CONSTRUCTION OF DYE HOUSES

(*Continued from page 674*)

Dye-House Piping

Each kettle has a hot-water, a cold-water and a steam connection which means a good deal of piping to care for and it should be laid out so as to be accessible and permit of changes. All cold-water piping must be below ground and is usually of cast iron run along the inside of the trench on the same supports as the machines. The high- and low-pressure steam and hot-water piping are run overhead and covered.

Steam Supply. The objection to the use of low-pressure steam in dye houses for boiling kettles has about vanished, and where an ample supply of clean low-pressure steam is available, as from either bleeder or non-condensing turbines, a considerable economy can be effected. For worsted piece dyes this steam must be free from oil, but in stock dyeing for woolens the exhaust from reciprocating engines can be used without injurious results if proper precautions are taken. If low-pressure instead of high-pressure steam is used at the kettles, the pipe sizes must be increased. Low-pressure systems have been condensed because of a failure to take this into consideration. A careful study should be made of the steam requirements of the dye house under consideration, especially with reference to peak loads and the pipe sizes proportioned to meet these conditions. The piping should be ample to provide for the future growth of the dye house and the possible rearrangement and changing of machinery. It is difficult because of the varying load in the dye house to maintain an economical heat balance, but much can be done in the way of economy by careful arrangement and the use of surplus steam to heat the water supply.

Warm-Water Supply. There should be provided, either close to the dye house or as part of it, an ample supply of warm water for washers, crabs, rinsing and such dye baths as can start with warm water. The simplest way to accomplish this is by means of wood storage tanks located high enough so that the water will flow by gravity to the machines. The water can be heated by exhaust steam or any other means. If there is a surface condenser in the power plant the circulating water can be used, and with a small sacrifice in vacuum can be delivered at about 120 deg. and pumped from the hot well to the tanks. The effect of this hot-water supply is to speed up the dye-house operations and reduce the peak load on the boilers.

Appeal to Members of The American Society of Mechanical Engineers on Behalf of Nolan Patent Office Bill H.R. 11,984

MEMBERS of The American Society of Mechanical Engineers are requested by the Committee on Patents of Engineering Council to communicate at once with their Representatives and Senators in Congress, and to Hon. John I. Nolan and Senator George W. Norris, who are the chairmen of the Patent Committees of the House and Senate, respectively, urging action upon the Nolan Patent Bill H. R. 11,984, in accordance with resolutions passed on October 21 by Engineering Council.

This bill has passed both the House of Representatives and the Senate and is shortly to be considered by a Conference Committee of the House and the Senate. As passed by the Senate, amendments were made reducing the patent-office force and salaries of the examining and clerical force in a way to make both seriously inadequate; and further, certain riders were made part of the bill, the effect of which would undoubtedly be to delay its passage.

The specific request of the Committee on Patents is that members ask to have the original values of the figures for the examining and clerical force of the Patent Office and the salaries of the employees restored, and that the riders be eliminated. The text of the Committee's recommendations and of the resolutions of Engineering Council (in abstract) are appended so that any members who desire to take action may have all the facts at their disposal.

The members of the Society will doubtless remember that they, in coöperation with the engineering societies represented in Engineering Council, together with other scientific and industrial organizations, have been giving support to an effort to relieve the present desperate condition of the United States Patent Office by passing Nolan Patent Office Bill H. R. 11,984.

The purpose of this bill is to increase the examining and clerical forces of the Patent Office and to raise their salaries so as to give that office a sufficient force and at salaries that will attract and hold competent men to enable it to make its examinations with that reasonable promptness which is necessary to make it worth while applying for them and with such thoroughness as to reduce the percentage of errors to as low a limit as sufficient time for the work and proper qualifications can possibly effect.

Engineering Council appointed its Patents Committee for the purpose of aiding the Nolan bill and urged the membership of the constituent societies to communicate with the Patent Committees of the House of Representatives and the Senate and with the Representatives and Senators from the districts and states of the respective members on behalf of the said bill. The influence thus exerted, and that of other organizations, was so powerful that, at a hearing before the Rules Committee of the House of Representatives, which was largely attended by officers of members of Engineering Council and of the said societies and organizations, the Nolan bill was ordered made special and the House of Representatives promptly passed it without amendment by a very large majority.

A similar hearing on the bill was held by the Patent Committee of the Senate, but, in order to remove objection to unanimous consent to a special hearing by the Senate, before adjournment of the session, the Patent Committee of the Senate consented to amendments so seriously reducing the force and salaries of the bill as passed by the House of Representatives as to reduce the examining and clerical forces below the numbers now actually employed in the Patent Office. The increases of the salaries provided in the bill were also cut down to where they are seriously inadequate to attract or hold a sufficient number of qualified men to enable the Patent Office to do its work. The steady exodus of examiners from the Patent Office, which has been going on for some time, has not been stayed at all by the passage of the bill by the Senate.

The bill was referred by the Senate to a Conference Committee, of which the Senate members are: Senator Geo. W. Norris, of Nebraska, Senator Geo. B. Brandegee, of Connecticut, and Senator William F. Kirby, of Arkansas.

The members of the Conference Committee for the House of Representatives have not been appointed, but Hon. John I. Nolan, of California, is certain to be one.

Engineering Council, regarding the matter as of grave importance, unanimously passed the following resolutions on October 21, 1920:

RESOLUTIONS OF ENGINEERING COUNCIL CONCERNING NOLAN PATENT OFFICE BILL

(Limited space has made it necessary to give these in abstract)

WHEREAS, the salaries of examiners, except for a war bonus, have only been increased ten per cent in seventy years and are so low that resignations of examiners are constantly occurring in a steady stream, averaging twenty-five per cent per annum, and resulting in such frequent changes that much inefficiency unavoidably results therefrom, even where examiners are qualified for the work, and many men are necessarily employed as examiners who cannot pass the examination required to qualify for their positions; and the salaries of the clerical forces are considerably below the average of salaries for corresponding work in the governmental departments generally; and

WHEREAS, as a partial remedy for such situation Nolan Bill H. R. 11,984 was introduced into Congress providing for an increase in the examining corps of the Patent Office of but five and eight-tenths per cent and an increase in the clerical force of but three and nine-tenths per cent, and providing increases in the salary for the position of primary examiners from $2700 to $3900 and of assistant examiners in proportion, and providing increases in the salaries of the clerical force only to bring them up approximately to the average corresponding salaries of other Government Departments and Bureaus, and as the cost of the increased salaries and force of the said Nolan Bill was more than met by an increase in the fees for patents provided therein; and

WHEREAS, the United States Senate so amended the said Nolan bill that instead of increasing it decreases the examining corps by fifteen and seven-tenths per cent and reduces the clerical force by about one per cent below the present insufficient numbers of said examining corps and clerical force actually employed in the Patent Office, as well as reduces the salaries, both of the examining and the clerical forces, so that the total present payroll is reduced five and nine-tenths per cent, notwithstanding that the increase in the fees for patents which were made to provide funds for the increased force and salaries were retained in the bill;

NOW, THEREFORE, BE IT RESOLVED: That Engineering Council, representing 45,000 engineers, regards it of large importance that the numbers of the examining and clerical forces for the Patent Office and the salaries therefore in Nolan Patent Bill H. R. 11,984 be restored to those in the bill as it passed the House of Representatives; that the bill be freed from any riders, such as Section 9 thereof, which may delay or jeopardize the passage thereof, and that the bill be made a law at the earliest possible moment.

As the Patent Office is steadily losing more and more of its competent men and is rapidly getting farther and farther behind in its work, and as to get much farther behind would mean for it practically to cease to function, and as the bill, as amended by the Senate, is wholly inadequate to accomplish its purpose, and would be worse than useless, every effort should be made to induce Congress to restore the figures of the bill to their values as passed by the House of Representatives.

The Conference Committee will probably take the bill up for consideration the middle or latter part of December. Each member of the Society is therefore most earnestly requested to write or telegraph to the member of Congress from his District, to the Senators from his state and to the members of the Conference Committee, urging that the figures of the Nolan Patent Office Bill H. R. 11,984 be restored to the values which passed the House of Representatives.

It would also be well to urge that the bill be freed from any riders not related thereto, so that its early enactment will not be hindered by opposition to such riders.

The names of the senators and representatives can be obtained from the World Almanac, or similar publications, and from postmasters.

In connection with this bill, engineers, as a class, for the first time, have exerted a powerful influence in a public matter, and they should see that their work is brought to a successful conclusion.

Yours very truly,
J. PARKE CHANNING
Chairman, Engineering Council

EDWIN J. PRINDLE, *Chairman*
J. PARKE CHANNING, *Secretary*
EDWIN J. PRINDLE (*A.S.M.E. Representative*)
D. S. JACOBUS (*A.S.M.E. Representative*)

DeLamater Collection Presented to A.S.M.E.

Messrs. Sydney and Victor DeLamater Bevin, members of The American Society of Mechanical Engineers, and descendants of Cornelius H. DeLamater, have recently presented to the Society the models, medals and plans formerly belonging to him. The collection consists of:

a One model solar engine, 6 in. high, made of brass and steel, in working condition
b One model hot-air engine of similar construction, in working condition
c One model steam engine
d One model cannon, mortar type
e Several medals awarded to C. H. DeLamater
f Set of miscellaneous plans belonging to the DeLamater Iron Works.

These articles, which are of historic value to the science of mechanical engineering, have been placed in the headquarters of The American Society of Mechanical Engineers at 29 West 39th Street, New York, N. Y.

MECHANICAL ENGINEERING

The Monthly Journal Published by The American Society of Mechanical Engineers

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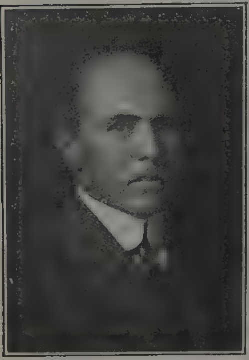
Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Why Not By-Product Producer Gas?



Robert H. Fernald

The rapid exhaustion of our natural-gas supply through criminal negligence and reckless extravagance resulting in drastic restrictions in order to conserve what little we have left brings us abruptly to a realization of the situation and leads us seriously to query regarding possible substitutions for this remarkable natural fuel.

The situation is acute. It is therefore imperative that we begin exhaustive investigations to determine the most practical solution of the industrial problems that have been for many years past so vitally dependent upon our natural-gas supply. The results reached through such investigations may lead into channels quite different from those under consideration at the present time, as the necessity of the situation may develop unthought-of possibilities.

With the limited amount of study that has been given to this problem to date, the most conspicuous source of relief seems to be through the development of by-product producer gas. This, of course, is practically an unknown field in the United States. Spasmodic attempts to develop interest have come to the attention of engineers from time to time but no serious study of the situation in its relation to the larger commercial developments of the country has as yet been undertaken.

In Europe we find by-product producer gas somewhat extensively used and the large central station near the mines, recovering the by-products from the fuel and distributing the gas under pressure for several miles through the industrial districts, has become a dependable source of supply.

Such plants produce in the neighborhood of 135,000 cu. ft. of 150-B.t.u. gas in addition to some 85 lb. of sulphate of ammonia and 100 lb. of water-free tar as by-products per ton of coal gasified. The sulphate of ammonia alone brings a handsome return to the plant, as it is worth, in normal times, about 3 cents a pound or $60 a net ton. The price for the last few years has, of course, been considerably higher.

The gas from one of the large central by-product plants in England is used for some thirty or forty separate purposes, including melting, welding, annealing, vulcanizing, hardening, enameling, and brazing, outside of a large demand for power. The gas is sold at from $1^{1}/_{2}$ to $2^{3}/_{4}$ pence per 1000 cu. ft., depending upon the volume of consumption. The net cost of the gas per 1000 cu. ft. for the year 1912 based on 40,000 tons of coal gasified, was 1.287 pence. This selling price of $1^{1}/_{2}$ to $2^{3}/_{4}$ pence is equivalent to about 3 to 5.5 cents per 1000 cu. ft. This, of course, is for gas averaging 150 B.t.u. per cu. ft., which is equivalent to from 12 to 22 cents for 600-B.t.u. gas or from 20 to 37 cents for 1000-B.t.u. gas based on the relative B.t.u. values alone.

Through the abundance of our fuel supply and our indifference to the needs of future generations, we have been ruthlessly extravagant and wasteful of our fuel resources during the past decades. An appreciation of the necessity of recovering by-products has but recently received thoughtful consideration from those agencies that are most seriously interested in the problems of fuel conservation.

At the present moment, low-temperature distillation processes are attracting more than casual attention. Investigation may show a combination of low-temperature distillation and the manufacture of by-product producer gas to be a distinctly economical and commercial solution of our natural-gas problems, as these processes, on the one hand, lead to the maximum by-product recovery and on the other, to a supply of gas commercially adaptable to heating and general industrial processes.

Our natural-gas situation is a serious one. The solution requires more than the casual financial interest of the private dividend seeker. It requires systematic study and research involving the expenditure of large sums of money. It is a problem of national importance and must be attacked on a broad basis. It calls for the best thought and most serious consideration of the ablest experts available, financially supported from sources that will guarantee the results of the investigation to be free from industrial or commercial bias.

It has been estimated that two decades will see the total exhaustion of the natural-gas supply. We cannot afford to wait longer.

Should not the engineering profession appeal to the Government n no uncertain terms regarding this necessity and see that the problem is vigorously attacked before the crisis is upon us?

Robert H. Fernald.

Forty Years Ago

The fortieth Anniversary meetings of The American Society of Mechanical Engineers held last month in various cities make it interesting to recall certain events in the mechanical engineering field which indicate what was the state of the art in 1880 when the Society was founded. A remarkable portrayal of the situation at that time is contained in the presidential address of the late Robert H. Thurston, given before the Society in 1881.

Unquestionably, the absorbing topic of the time was the promise of electricity as a useful agent in industry. The Brush dynamo-electric machine had been invented in 1876 and the Edison carbon-filament incandescent lamp in 1880. Three years later, so rapid had been the progress of the electric light, that there were 400 electric-light stations in operation in this country. The possibilities of this development are told so fascinatingly by Doctor Thurston that his allusion to the subject in his presidential address is here quoted in full:

"That feature of recent progress in engineering which is today attracting most attention and awakening most interest in the minds of the public as well as of the profession, is the introduction of machine-made electricity, and of the electric light, but what seems to me the most important phase of this impending revolution, is I think, not yet generally comprehended. By the ingenuity and skill, the courage and persistence, the energy and enterprise of our brother engineers, Brush and Edison and their coadjutors, it seems certain that the dream of the great author of "The Coming Race" will in part be speedily realized, and that for the occasional mild light of the moon, or the yellow sickly flare of the gas flame, will soon be substituted the less uncertain and always available, and always beautiful and mellow, radiance of the electric flame. This is but a beginning, however. A few months ago one of the most earnest and best workers of all who have been with me, at once, friends and pupils, made a very painstaking investigation of the efficiency of a powerful dynamo-electric machine kindly loaned him from Menlo Park. The mean of several series of tests gave, as a result, an efficiency of between 90 and 95 per cent. That is to say, of all the power transmitted to the machine from the steam engine driving it, over 90 per cent appeared on the wire in the form of electrical energy. It follows at once that mechanical power may be transmitted through two such machines, again appearing as mechanical power, with a loss of less than 20 per cent. And it follows from this last fact that the distribution of power by electricity is not unlikely to prove a more important application of this wonderful force than is the electric light."

Inasmuch as we have just emerged from the Great War, it may be noted that it was only in 1880 that the manufacture of modern steel guns was projected in this country, with imported Whitworth steel; and that it was not until several years later that the Whitworth fluid-compression process for steel forgings, both for artillery and for the heavy parts of steam and electric machinery, was introduced in this country. In general, this period was marked by the substitution of high-carbon steel forgings for wrought-iron forgings, and of mild-steel plates for boilers and ships in place of wrought-iron plates, a fact alluded to by Doctor Thurston.

In 1880 the Corliss engine was supreme—it was a period of transition between the big, slow-moving, low-powered Corliss steam engine of the Centennial and the high-speed engine of the nineties. The Otto "silent" gas engine had been in the country four years and held the field until the expiration of the Otto patents in 1890. Referring to steam engineering and the gas engine, Doctor Thurston said in part:

"This figure—16 lb. of steam per hr. and per hp.—(from a Leavitt hoisting engine at Hecla) may be put on record as the very best economy attained by our best engineers at the end of the decade 1870–1880. It is just double the weight which would be required in a perfect engine working steam of the same pressure at maximum efficiency.

"The compressed-air engine, the petroleum engine, and the gas-engine are all just now coming forward. I have no figures that I can rely upon except for the gas engine, which sometimes consumes as little as 28 cu. ft. of gas (1 cubic meter nearly) per hr. per hp.

"Today a steam pressure of six atmospheres (75 lb. per sq. in.) is usual, and 7 atmospheres (90 lb.) is often adopted. Increased pressure has been accompanied by increased speed of piston—from 300 to 500 ft. per min.—and both causes have combined to reduce greatly the size and weight of engines. The consumption of fuel per hour and per horsepower has decreased from 2 lb. to 1.8 lb."

The error which had been fallen into by many writers on the steam engine to the effect that the condensation in the steam-engine cylinder was due solely to the conversion of heat into work, was also pointed out by Doctor Thurston, who said: "It is becoming generally recognized and writers are in a fair way to learn that it is not the fact that the greater part of the liquid water which collects in unjacketed cylinders is produced by liquefaction of steam during its expansion, but that this latter amount is insignificant and that this comes of cylinder condensation, sometimes with a considerable leakage, and often amounts to half or more of all the fluid supplied to the boiler." In other words, the action of steam in the engine cylinder was but beginning to be understood by engineers in general.

Locomotive practice is summed up as follows:

"Locomotives are frequently built weighing 50 tons; 70 tons has been reached, and every builder of engines is ready to guarantee the performance of an engine to draw 2000 tons 20 miles an hour on a level track. In coal consumption we have made some saving of late years. Three pounds of coal per hour and per horsepower is a usual amount, and a consumption of 2.6 lb. of coal, and of $22^{1}/_{2}$ lb. steam has been reported from recent tests."

Finally, in two trite but effective sentences the labor situation is thus recorded:

"When the last generation was in its prime our factories were in operation 12 or 13 hours: 'Man's work was from sun to sun, and woman's work was never done.' Today man works ten hours, and woman is coming to a stage in which she will work where, when, and how she pleases."

Finding Jobs for Things

One of the most interesting branches of modern engineering is that which deals with the discovery of new uses for materials and equipment which have lost their applications and remain for a while, so to speak, jobless. The war, in particular, may be regarded as an example of an immensely vast industry which has ceased, and whose raw materials, formerly developed for the destruction of life and property, must now be put to some useful purpose.

For a great many materials "jobs" have already been found, and what follows must therefore be considered merely as examples and possible suggestions of future applications.

During the war, as a protection against the employment of poison gases, highly efficient gas masks were developed, and now that the war is over it is an obvious step to apply them to mine-rescue work and the protection of men engaged in handling poisonous materials. A less obvious matter is that of utilizing ill-smelling gases, a vast number of which were developed for military purposes. It is now suggested that such gases should be used in mines to notify the men, in case of accident, of the necessity for escape; for tests have shown, especially in mines supplied with artificial ventilation, that ill-smelling gases carry their message more rapidly and certainly than sounding devices.

Another war development which is finding application in peace time is the guide cable which was employed by the Germans around Heligoland to permit submarines to return through the mine field to their bases. The cable was laid in such a manner as to indicate safe passage and oscillations sent through it could be caught by an appropriately attuned receiver. At the present time experiments are being carried out by the U. S. Navy with a view to applying the same scheme for guidance of vessels entering harbors in a fog.

But the problem that is of particular importance, however, is in connection with the numberless materials which are becoming available every year as by-products of other manufactures. Selenium is one of these. Before the war it was almost exclusively used for electrical purposes, where its value lay in the fact that its electrical conductivity varies with the intensity of the light to which it is exposed. During the war, when this country experienced a great shortage of manganese, selenium was extensively used to take the place of this material in glass manufacture. The amount which is produced in the copper industry, however, is so large that it has become an important problem to find some peacetime commercial application for this interesting material. It has been recently announced that such an application has been found, due to the discovery of the fact that selenium oxychloride is a powerful solvent for a number of materials such as paraffin, etc.

There is still a third problem associated with this discovery of new uses for materials and it deals with the employment of rare materials. Vanadium, for instance, was for many years known only as a laboratory curiosity. It was known, in general, that it improved the quality of steel, but not enough of it was available to make the work of investigation worth while. Shortly, however, great deposits of it were found among the hitherto inaccessible peaks of the mountain ranges of Peru and in a few years vanadium became a recognized agency in the production of high-grade steel, for which at just about the same time, a big demand was created by the automobile industry.

Another similar material, molybdenum, is still in what might be called a probationary stage. It is well established that under certain conditions molybdenum does improve steel, but just what these conditions are is still a somewhat mooted question; furthermore it is not as yet definitely established whether or not the same results can be obtained at the same cost with such other materials as tungsten or chromium.

There are, however, many materials produced or available in quite substantial quantities for which no suitable use has as yet been discovered. As such may be mentioned, for example, calcium chloride, which is a by-product of soda manufacture.

Another by-product which is still waiting for some one to discover a use for it is straw. Of this many millions of tons are produced a year, and yet, notwithstanding the active work done by the various departments of the Government and in private laboratories, no real use has been found, which may be due partly to the fact that straw is a seasonal material and as such is particularly difficult to handle commercially.

The question of utilization of either waste or idle materials is a large one for our national industries, as it represents one of the most logical ways to cut down the unit costs of production. The packing industry realized this many years ago and boasted for years that everything in the pig except the squeal was put to commercial use. In fact, it is believed that one of the reasons for the tremendous growth of packing establishments and the very generous profits which they have made for their stockholders has been this very fact of utilizing practically 100 per cent of what goes into the stockyards.

The mechanical industries are still very far from this ideal, although doubtless the present high costs of labor, materials, and doing business generally, are proving to be a powerful incentive toward eliminating all sources of waste and putting all by-products possible to useful employment.

Fuel and Power Conservation on the Pacific Coast

Special Correspondence

At the present time engineering affairs on the Pacific Coast are rather quiet, and I think it might be said that the great majority of what might be called engineering or industrial capital is feeling its way very carefully before deciding on any investment of funds. This is partly due to the political situation, but more I think to the great uncertainty as to future moves of labor organizations.

Recent conditions on the Pacific Coast have concentrated the attention of engineers there on the question of power supply and the more economical use of power. Inadequate rainfall for three successive seasons and a very light precipitation of snow in the mountains had, during September of this year, forced the power administrator of California to issue an order that all power users must reduce their consumption twenty per cent and that all electric display signs and unnecessary lighting must be discontinued.

During this same three-year period the cost of fuel oil, the universal industrial fuel of California, had risen by leaps and bounds, and early in the spring of this year managers of industry were thrown into a near panic by the publicity given to the fact that our available supplies of fuel oil were almost exhausted. These facts and circumstances have combined to direct the attention of engineers very emphatically to the problem of power conservation, and much activity is evident in that direction.

One very interesting instance of this activity lies in the careful investigation which is being made by railroad engineers into the economy of electrifying all of their lines and also into the problem of applying Diesel engines to train propulsion, and the suggestion has been made that perhaps these two propulsive methods might be combined.

The great difficulty in applying the Diesel or any other internal-combustion engine to railway propulsion lies in securing sufficient initial torque for starting a train. This, of course, could be readily overcome by using an electric locomotive which would be coupled with a Diesel-electric generating plant on a separate tender or car. This equipment could be used on portions of the rights of way distant from hydroelectric development. The same locomotives could pick up power from transmission lines where they were readily available.

Probably the greatest benefit which will be derived from this power-conservation movement will come through a careful engineering survey of the sources of supply and a concerted coöperative effort to apply power from those sources in the most efficient and useful manner. Undoubtedly, as has been pointed out in many articles in the technical press, the majority of power users are wasting a large percentage of the power in its application. This is particularly true in the plants which have sprung up during the emergency shipbuilding program, many of which are now endeavoring to adjust themselves to the changed conditions and to compete in general and industrial engineering practice.

When we consider the economies that can be gained from installation of the best apparatus for the utilization of the energy in fuels as compared with the very low percentage of that energy utilized by the makeshifts often in use, we are almost forced to the conclusion that the use of much of this apparatus should be made an economic crime and that all applications of power should be under proper supervision. As Franklin K. Lane has so well said, every man who uses fuel oil under a steam boiler should be made to show good reason for the apparent waste of a valuable commodity.

Notwithstanding all of this agitation and activity directed toward power conservation, we note the sorry spectacle of the Shipping Board taking a backward step by removing from several of its vessels water-tube boilers and geared turbines and substituting therefor Scotch boilers and reciprocating engines. This leads us to remark that now, as in every period of the history of modern engineering, the greatest enemy to advancement has been prejudice and obstinacy on the part of operating engineers themselves, and this seems to be true to the greatest extent in our own United States where one would least expect it.

During the first three weeks of October there came considerable general rainfall all over the state of California and an abundant snowfall in the mountains, and while the engineers are still laboring on the problem, the popular demand for its solution has vanished overnight, the power commissioner has rescinded the order for a twenty per cent reduction, and display signs, street lighting, etc., are running full blast; but the industrial managers facing the problem of costs find it necessary to trim at every point in order to compete, and in all probability a great deal of permanent benefit will come to the industries of the Pacific slope through this power-shortage scare.

I shall hope in future correspondence to report substantial progress along some of these lines and perhaps be able to make a few suggestions for the benefit of engineering societies and local sections thereof. A. J. DICKIE.

James Hartness Elected Governor of Vermont by Big Majority

James Hartness, past-president Am.Soc.M.E., ran ahead of the presidential ticket in his election as Governor of Vermont. Harding was accorded a majority of 44,300 and Hartness 47,400. The total vote for Hartness was approximately 65,950 and for Martin, the Democratic candidate for governor, 18,550. As previously explained in these columns, Mr. Hartness conducted his campaign for the gubernatorial nomination on a platform calling for the development of the industries of Vermont, similar to that which has taken place at his home town of Springfield. This has become very much of an industrial center through the local encouragement offered to home talent and home firms.

President Burton Inaugurated at University of Michigan

The inauguration of President Marion Leroy Burton at the University of Michigan took place on the morning of October 14. In addition to an address by President Emeritus Hutchins and President Burton's inaugural address, there were others on the functions of the governing board and the faculty in the administration of a university.

President Burton's inauguration was the occasion for an educational conference which was opened on the afternoon of October 14 by a session devoted to a symposium on educational readjustments. The conference continued on October 15 with symposiums on administrative problems and on constructive measures. There were four speakers at each o these symposiums and many problems of the present-day university were discussed. The conference closed on October 16 with a meeting of the regents of state universities at which the salary problem and student fees and tuition charges were discussed.

JOHN R. ALLEN

JOHN R. ALLEN, director of the Bureau of Research of the American Society of Heating and Ventilating Engineers in coöperation with the U. S. Bureau of Mines, and vice-president of The American Society of Mechanical Engineers, died on October 26 of pneumonia. Professor Allen contracted a cold when in Detroit to give an address early in October. He recovered from this and went on to Philadelphia where he spoke for an hour and a half the evening of October 14. The next day, Friday, he attended the A.S.M.E. Council meeting in New York and on Saturday participated in a conference on the ventilation of the New York-New Jersey Vehicular Tunnel. He arrived home early Sunday morning feeling very ill and went immediately to bed. Toward evening he was again about for a little while, and for the last time. Pneumonia had set in. He died on Tuesday afternoon, October 26. Funeral services were held in the First Baptist Church of Ann Arbor, on Friday, October 29, at which the Society was represented by Dean M. E. Cooley and Prof. H. C. Anderson, appointed honorary vice-presidents by President Miller to attend the funeral.

John R. Allen

Professor Allen was born in Milwaukee on July 23, 1869, and received his preparatory education at Milwaukee and at the Ann Arbor, Mich., high school. In 1892 he was graduated from the University of Michigan with the degree of B.S. (M.E.), receiving his master's degree from the same institution in 1896. For two years he was connected with the L. K. Comstock Construction Co. From 1896 to 1911 he was associated with the University of Michigan, rising from an instructorship to a full professorship. In 1912 he was called to Robert College in Constantinople, Turkey, as dean of the engineering department. Two years later he returned to the University of Michigan as head of the mechanical engineering department, being so connected until 1917, when he became dean of the college of engineering and architecture of the University of Minnesota. In August 1919 Professor Allen accepted the directorship of the Bureau of Research of the American Society of Heating and Ventilating Engineers, with headquarters at the U. S. Bureau of Mines, Pittsburgh.

Professor Allen was extremely active in the work of engineering societies, having been a past-president of the American Society of Heating and Ventilating Engineers and of the Michigan Engineering Society. He was an honorary member of the National District Heating Association, a member of the British Institute of Heating and Ventilating Engineers and of the Society for the Promotion of Engineering Education. He was also a member of the honorary societies, Tau Beta Pi and Sigma Psi. He became a member of our Society in 1894, and at the time of his death held the office of vice-president of the Society.

Professor Allen has been a contributor of important technical papers to these societies, papers which have proved to be reference works of great value. He was the author of textbooks, not only on the subject of steam engines, which he taught, but also on heating and ventilation. His book on the latter subject is recognized throughout the country as a standard. His long connection with the University of Michigan gave him a wide acquaintance and he was called for consulting work to all parts of the world. Notable among his engineering activities during the period of his connection with the University of Michigan were his expeditions to the unexplored districts of western Mexico to report upon the existence of rubber-producing trees; to the Rocky Mountains to report on water-power projects, and his engineering expeditions into northern Michigan and southern Canada.

A great lover of outdoor life, Professor Allen was the owner of two beautiful farms in the outskirts of Ann Arbor, one of which was owned jointly with his adopted son. He brought the boy back with him from his Mexican expedition and adopted him that he might have the opportunity of coming to this country and of being educated here. This boy, who is a native Mexican Indian, has of late years operated both farms, and it was Professor Allen's great pleasure to spend much of his leisure time in farming.

He leaves a wife and daughter residing in Pittsburgh, his daughter attending the Margaret Morrison school of Carnegie Institute.

Words of Appreciation

From Dean M. E. Cooley, a very close friend of Professor Allen's, comes the following appreciation:

> Prof. John R. Allen's death was untimely. It came in the midst of his most important life work, apart from his teaching days. He was intensely interested in his heating and ventilating researches, and was trying to establish fundamental laws governing the flow of heat under a variety of practical conditions. A number of colleges were coöperating with him. A year or two more would have seen certain benchmarks firmly established. His death was indeed untimely.
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> Professor Allen was a man of charming personality. He had a host of friends. In the honor Society of Michigamua here at Michigan his Indian name was "Man of Many Friends." He sat in well at committee meetings and conferences. Always careful of the feelings of others and respectful, difficult situations were overcome and his own views, even when radically different, were well received. He took advice well and was himself a good adviser. He was a splendid teacher. His students respected and admired him. He was a good influence on the young men who sat under him. He was one about whom the older alumni inquired years after their college days. That fact alone marked him with especial honor in the teaching world.
>
> Professor Allen was a well-poised man. Unpleasant things did not upset him. He never lost his temper. His rule was to forget unpleasant things—at least to ignore them. If he could not get away from them in one locality he would move to another. Nothing seemed to ruffle him. At least he did not show it. And yet he was sensitive and easily hurt, but always ready to forgive and start over again.
>
> Professor Allen was resourceful and adaptable. He got on well. In foreign countries he had the same respect and devotion from those with whom he came into contact as at home. He was quick to learn the peculiarities of men and to act accordingly. Rarely did anyone get the better of him for long. His construction gangs frequently embraced Italians, Greeks, Turks, Bulgarians, Armenians. But whatever their nationality, men would work for him cheerfully and well.
>
> Professor Allen loved companionship. He enjoyed his friends and could not do too much for them. He was a good banqueter and could always be relied on for some post-prandial remarks. He enjoyed speaking in public and was more than generous in responding to invitations to address gatherings. His experiences in Mexico when investigating rubber-producing trees, and in Turkey, were favorite non-technical subjects and he made them very attractive with his lantern slides.

The following letter has been received from Prof. O. P. Hood, chief mechanical engineer of the U. S. Bureau of Mines, Washington:

> Wherever John Allen made contact with people or work, there will be a keen sense of loss at his going.
>
> Dean Allen came to Pittsburgh in a scientific adventure, the coöperative agreement between the American Society of Heating and Ventilating Engineers and the Bureau of Mines being new and untried as a method of furthering science and technology. His selection to head the work proved so happy that the Bureau had no fears whatever for the character of the output. He dropped into the organization with the greatest accommodation, fitting himself to the situation so graciously as to win instant appreciation from all the members of the Bureau of Mines with whom he was brought in contact. Kindly and helpful in every situation, he was a stimulus to good work. The installation of equipment was just being completed and we all looked forward to an early output of valuable information.
>
> The sense of personal loss to members of the Bureau will be slow to fade.

Fortieth Anniversary Meeting of A.S.M.E.

Special Meeting in New York with Addresses on the Opportunity and Responsibility of the Engineer by J. Herbert Case, Federal Reserve Bank of New York, Samuel Gompers, and William B. Dickson

THE special meeting of The American Society of Mechanical Engineers called to celebrate the Fortieth Anniversary of the first meeting of the Society was held in the Engineering Societies Building, New York, on the evening of November 5. Coincident with this general meeting were meetings in different parts of the country of 32 of the 38 sections, all of which contributed to a most appropriate recognition of the growth of the Society, its far-reaching influence and its long period of service.

As a means for "tying-in" the various meetings the plan was carried out at the suggestion of one of the members, Mr. William H. Bristol, of Waterbury, Conn., of having phonographic records made of speeches by officers of the Society to be distributed to the different Sections for use on the evening of the celebration. Mr. Bristol has been working on a device for synchronizing phonograph records and moving-picture films, and in fact has so far perfected the method that a demonstration with films and records was made at Waterbury before the Section meeting there, which was the first public exhibition of the synchronizing device. The records distributed were of addresses by President F. J. Miller and Past-President I. N. Hollis.

Another tying-in feature was effected through the coöperation of the American Radio and Research Corporation, at Medford, Mass. and its vice-president, Mr. H. J. Power. Greetings from Harding and Coolidge, Mayor Peters of Boston, the Boston Section, Dean Anthony of Tufts College, and the company, were radiophoned to Local Sections throughout New England and as far as Ontario, Canada. President-Elect Harding sent "Greetings and good wishes to The American Society of Mechanical Engineers on the occasion of the celebration of the fortieth anniversary of the organization. The Administration which comes into power next March fourth very much wishes the advice and coöperation of the membership."

The meeting in New York was on the subject of The Opportunities and Responsibilities of the Engineer, with a program arranged by a special committee appointed by the President, consisting of Henry R. Towne, past-president, chairman; Harry A. Hopf, vice-chairman; W. Herman Greul, secretary; William H. Wiley, treasurer of the Society; Frank T. Chapman, representative of the New York Section; and L. B. McMillan, representative of the Committee on Meetings and Program.

The program consisted of preliminary remarks by Henry Towne, the oldest past-president of the Society; A. P. Davis, president A.S.C.E.; William L. Saunders, past-president, A.I.M.E.; and Charles F. Scott, past-president, A.I.E.E. Following these were the three principal addresses: by J. Herbert Case, acting governor, Federal Reserve Bank of New York; Samuel Gompers, president, American Federation of Labor; and William B. Dickson, steel manufacturer. Extended abstracts of these addresses conclude this report.

President Miller presided and said that forty years ago the first regular meeting of the Society was held at the theater of the Union League Club, then at 26th Street and Madison Square. At that time there were enrolled on the books of the Society 189 members and 85 of them were registered as having been in attendance at that first meeting. Continuing, he said:

> When a man reaches his fortieth year, he is generally conceded to have reached the zenith of his power of production; but there is no age limit on associations of men—societies of men may be afflicted with some things analogous to old-age infirmities, but when they come they are usually the result either of a lessening opportunity for rendering service, by change of conditions, or by reason of bad management in the affairs of the societies. Our opportunities for service seem to be expanding, and in so far as we can see, they appear to have no limit. With our Local Sections now numbering 38, scattered over the industrial centers of the country, with our student branches now numbering 53, located in the educational institutions at which engineering is taught; with our recently formed Professional Sections now numbering eleven, our participation in the United Engineering Foundation, and in the American Engineering Standards Committee, and in the conduct of our Journal, to mention only the major lines of activity in which the Society is engaged, it can be seen that we are a very active Society.

Remarks by Representatives of the Four Founder Societies

REMARKS OF HENRY R. TOWNE

Mr. Towne's remarks consisted chiefly of reminiscences of the history of the Society. He said, in part:

> I became a member of this Society in 1882, about two years after its organization. The first meeting which I attended was held in October 1883, under the presidency of Mr. Leavitt, in what was then the house of the American Society of Civil Engineers in East 23d Street, which the older members will remember, and we had at that meeting an attendance of about 150. The total membership of the Society at that time was about 600.
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> Today, to make the contrast at once, the Society has a membership of 13,500, and is still going strong, and the attendance at its meetings approximates thousands where formerly it was only in the hundreds. In the same connection I may mention the fact that the income of the Society in that year was some $7560, whereas its budget for the coming year, I understand, approximates a half million of dollars.
>
> That meeting was signalized also by the evening session of the second day which was devoted to memorial services for one of the most distinguished American engineers and one who is held in affectionate remembrance by all who knew him—Alexander Lyman Holley. The presiding officer on that occasion was Prof. R. H. Thurston, the orator was Dr. Rossiter W. Raymond, and the mover of the final resolution was Mr. James C. Baylis, names familiar to all the older members.
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> In that connection I may recall that my predecessors, seven of them, were Prof. R. H. Thurston, the first president, followed by E. D. Leavitt, Prof. John E. Sweet, J. F. Holloway, Coleman Sellers, George H. Babcock, and Horace See, all of whom have joined the great majority.
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> At the meeting of the Society held in Chicago in 1886, owing to the absence of the President, Mr. Coleman Sellers, because of his unfortunate incapacity due to a very serious operation, I, being the senior available vice-president, was called to serve in his place. At that meeting I had the honor of presenting a paper under the title The Engineer as an Economist, and I believe those who are interested in and familiar with the record of this branch of our professional work credit that paper with being the earliest publication of any kind, in the English language, certainly, to propose that the mechanical engineer in his organized society should take up the study of economics as related to his work, the justification for that being, in the case of our Society, in particular, the fact that probably a majority of mechanical engineers are identified more or less closely with managerial positions, as superintendents or directors of industrial operations. I had noted at that time that there was a gathering volume of data and information and experience in that important field, but no channel for its continuation, for its diffusion, and for its utilization, no channel either of printing or of meetings for discussion.
>
> I thought, also, that it marked the dawn of a new science, and that The American Society of Mechanical Engineers, more fittingly than any other organization, could sponsor the growth and development of that science. The suggestion was accepted, the Society has acted upon it from that time to this, and the result has been a great and growing volume of material relating to that subject in our discussions, and in our transactions and public papers.
>
> Now, that fact is directly germane to the program for this evening on the subject of The Opportunities and the Responsibilities of the Engineer. In my opinion, the responsibilities of the engineer have become very definite and his opportunities are almost limitless. Mechanical engineers in particular, who are brought so directly in contact with productive operations, have a great opportunity and an equally great responsibility to see that they do their full share in promoting the advance of the new era and the new conditions which it implies and to which it has given origin.
>
> These new conditions are divided under two heads and can be summed up perhaps in two words: efficiency and coöperation. Efficiency of methods of machines and of processes; and coöperation between those who plan and direct the machinery of industry and those who operate it. The old order is passing. Especially is that true in our method of compensation, the compensation for labor. The old methods have served their purpose fairly well, but they are not adapted to present conditions—they are going to be superseded by newer and I believe by better methods. We will be called upon to meet a great diversity of conditions in the different industries, and these in turn must be worked out by the collaboration of the industrial engineer, and the labor leader. By coöperation between these two elements the problems which will confront us will be solved, and we are going to have greater efficiency, greater productiveness, and there is no greater thing in the world today than that, and with it will come greater possibilities of friendship and good will.

REMARKS OF A. P. DAVIS

Mr. A. P. Davis extended the congratulations of the American Society of Civil Engineers to The American Society of Mechanical

Engineers on the completion of its fortieth successful year of operation. He congratulated the Society not only upon its age and upon its growth, but on its activity and its progressiveness. In this connection he said:

> I had the honor of being called on by your President recently to dictate a brief greeting to be read at the meetings of the Local Sections of this Society on this occasion, the 40th anniversary of the organization of the parent society, and in that greeting I was glad to state that the usefulness and progressive character of The American Society of Mechanical Engineers was a bright example to be followed and emulated by the older, but smaller and less progressive—though I hope not less useful—organization, the American Society of Civil Engineers.
>
> The American Society of Civil Engineers is now nearing the culmination of an effort to shake off the lethargy of the past, and to become a worthy member of what is known as the Four Founder Societies. The ballot will be opened and counted on next Monday, and on that day we hope that the American Society of Civil Engineers will seal the bond of fellowship with the other three Founder Societies which have entered upon a larger and more useful field than they have occupied heretofore, in joining and leading and forming and molding a federation of all the engineers of the United States into one great Federation, which can work together and be really and truly representative of all the engineers of the country, and speak for them as a body.

Mr. Davis pointed out the opportunities for expansion of engineering activities, referring to the developments resulting from the World War and concluded by saying:

> Among those leaders of thought I place foremost the engineers of the world, the educated, experienced men, whose capacity has been demonstrated in the last few years; and whether or not that influence is to be for good or for evil depends on the activity of the people I see before me, and those corresponding to them in the other Founder Societies.

Address of W. L. Saunders

Mr. Saunders, representing the American Institute of Mining and Metallurgical Engineers, discussed four points regarding engineers. These points are given briefly in the following abstract of his remarks:

> I occupy a rather difficult position tonight, in that I am expected to represent Mr. Hoover, but I take pleasure in the thought that the man I represent is particularly representative of the subject which called us together tonight—the engineer, not specifically in his technical work, but in his usefulness to society in general.
>
> There are certain thoughts which I should like you to carry away with you tonight, and the first one which impresses itself upon me is this—that the engineer is moving upward and broadening his influence. When I sit on this platform and look at my old friend Samuel Gompers and see him coöperating with us in a meeting of this kind, I rejoice in the knowledge that the profession to which I belong is now one which recognizes the human side of industry, which recognizes, as ex-Mayor Seth Low once said, that a man should have the right to have something to say about the conditions under which he spends the major portion of his life. The second thought which occurs to me, which is closely allied with the first, is emphasized in the fact that this meeting is not merely an experience meeting, not merely a meeting of men and women who have come together to say "We are now forty years old, let us talk about the great things we have done in the past—let us be reminiscent," but it is a meeting to call serious attention to the fact that this forty years of service of engineers brings upon our shoulders greater responsibilities and duties for the future. Let us not forget that, because we have done things in the past in engineering lines, because we have build up this country as a great industrial nation, we have now to face the responsibility of seeing to it that the engineer not only maintains what he has built up, but that he carries it to greater usefulness.
>
> The third thought which impressed me tonight is this: Mechanical engineering is the basic science of all engineering. And the fourth and last thought that I should like you to carry away with you tonight is that these organizations of engineers, the four Founder Societies, and particularly the mechanicals, represent the spirit of coöperation—the spirit of collectivism as distinguished from the spirit of individualism. By getting together, as these societies do, and matching ideas and doing teamwork, they get results, not only for the societies and for the concerns they may represent, but for each individual. It is teamwork which tells.

Remarks by Charles F. Scott

Mr. Scott, who was chairman of the committee which had charge of the construction of the Engineering Societies Building, spoke of the services rendered by Mr. Calvin W. Rice, Secretary of The American Society of Mechanical Engineers, whose activities eighteen years ago as chairman of a prior building committee, made this building possible.

Reviewing the achievements of the past forty years, Mr. Scott said:

> During this forty years the population of the United States has doubled; the value of the manufactured products of the country have been increased sixfold; the amount of power which is used in manufacturing, twelvefold; our railway traffic, as measured in ton-miles of freight carried, tenfold. During this same period of forty years other increases have been even greater, for the use of electricity has increased from meager beginnings to the gigantic position, which it now holds. The telephone—the high-speed tool of modern business—has increased from its comparatively small beginnings until now there is a telephone for every ten persons in the United States, and the increase in the number of engineers is typified by the growth of The American Society of Mechanical Engineers, from less than 200, at the beginning, to more than 13,000 at the present time. I understand that the increase in membership during this past year has equalled the total membership at the end of the first twelve years.
>
> While the population has been doubling, the fundamental activities of engineering production and transportation and communication have increased fivefold, tenfold, one-hundred fold. The annual increment is as great as the total a decade or a score of years ago.
>
> Life today is different from that of our grandfathers, because of the things which engineering has supplied. Relationships are different, and so families and communities are no longer free and independent and self-supporting. The factory and the railroad have made us interdependent for food and clothing, fuel and shelter, and health and pleasure.
>
> Nations are no longer isolated and apart. Steam and electricity have cast aside the barriers of space and time. The whole world today is no longer the original thirteen states when measured in time of travel or facility for the transport of food and materials. This new interdependence of communities or nations is based upon the methods of industrial production, and of transportation and communication which the engineer has developed, and which he alone understands and can efficiently operate. From these have arisen new customs; the standard of living has been elevated; new ideals and aspirations have been awakened and new possibilities for benefiting or harming others have been placed in the hands of small groups of men.
>
> As a result of all this, what are the responsibilities of the engineer? The engineer has responsibilities because he has produced power and has applied it to transportation and industry and because this has given the world new activities and capabilities for doing things on a gigantic scale that have changed the whole character of civilization. He has ushered in a new epoch and it is his responsibility to see that this great mechanism which underlies modern society is kept moving and that the tremendous forces which he has produced are not diverted to its destruction.
>
> What are the opportunities of the engineer? It is his opportunity to extend and multiply the means of production and transportation which have already transformed our mode of life. It is his opportunity to coördinate on a larger and larger scale the engineering activities which have grown up independently. It is his opportunity to coördinate in national scope interests which are separate and overlapping and duplicating. It is his opportunity to apply the principles of physical efficiency to human action. It is the opportunity of the engineer to be a leader in pointing out the direction of future development and to direct the trend of human activities along the paths of the highest ideals. The modern engineer is the director of the human as well as the material and inanimate. He determines the abilities of men as well as the qualities of materials.
>
> Nearly forty years ago David A. Wells wrote that the economic changes due to the introduction of the steam engine and machinery brought about the world-wide depression and panic of 1873. But those changes were small compared with those of recent years. Readjustment to the new order of things which engineering and power are producing in modern life—in industry and social and material affairs—will be far-reaching. It will involve evolution, possibly revolution. The problems are many and complex. But to the engineer a problem is an opportunity.

In the course of the evening President Miller read congratulatory messages from President-Elect Harding, Governor Coolidge, Hon. Andrew J. Peters, Mayor of Boston, Herbert Hoover, E. A. Carman, President-elect of the A.S.M.E., the American Engineers in Cuba and the Institution of Civil Engineers of London. Greetings were also sent by a number of the Sections of the Society and by absent members. Mr. W. H. Patchell, a member of the Council of the Institution of Mechanical Engineers of London, was present and read a cablegram from that Institution.

Addresses by J. Herbert Case, Samuel Gompers, and William B. Dickson

Address by J. Herbert Case

The Constitution of your Federated American Engineering Societies defines your profession "as the science of controlling the forces and of utilizing the materials of nature for the benefit of man." I should like you to think of banking as a profession with essentially similar aims. I conceive that our professions and our functions are not vitally different.

More and more the banker is becoming, in a sense, a financial engineer, and adopting essential engineering methods. I have hopes that in the future we shall be able to deal with banking and financial problems as concretely and with the same sureness and knowledge as the mechanical or electrical engineer does now with his problems.

Ever since the banks took on the function of loaning money, this has been the intent. The mechanical engineer wishes first of all to know the strength of his materials. So, in a way, does the banker. But I think we are presently to go much further than this. The banker of the future will have a variety and definiteness of knowledge that the bankers of the past have not had. Moreover, he will endeavor to do exactly what the engineer endeavors to do in calculating the weight and size, of his constructions. He will have to do with stresses and strains and the means of meeting them so that there shall be no breakage and the least possible friction.

It has been the endeavor of more than a generation of thoughtful bankers and economists to devise a banking system which would meet periodic strains so that acute commercial or financial crises might be avoided, exactly as the engineer, for example, plans a bridge to meet every possible strain that can be put upon it, an unusually heavy load, a freshet, an unexpected hurricane, the ordinary dangers of fire and water. I think this endeavor has been successful.

We have witnessed in the past few years a remarkable expansion in credits and during recent months a very remarkable fall in prices. I am not sure that it is not the most remarkable fall in prices, taken as a whole, of which we have any accurate record.

Without wishing to exaggerate the fact, it is easy to see that these prices declines in commodities, whose annual worth runs into the billions of dollars, must in the aggregate have represented an enormous sum. What I wish to point out to you is that all this has taken place without any violent rupture or breakdown, such as has often characterized the past. And I want you to consider the reason why.

The reason why, as I see it, is that, taking a leaf from the basic principles of engineering, there has been introduced into our banking and financial system a greatly augmented factor of safety. We have approximately 10,000 of these banks, representing 70 per cent of America's banking assets, welded together into a coherent and smoothly working system wherein, practically speaking, the resources of these 10,000 banks are more or less pooled, within reasonable limits, and in such a way as to enable them to meet almost any probable strain. Although these 10,000 banks are a trifle less than one-third of the total number, their resources are more than two-thirds of the total banking resources of the nation. Their aggregate deposits are in excess of 20 billions, a fabulous sum even in these days. It is to my mind unthinkable that with 10,000 banks possessing such resources as these, welded together, and pooling their reserves, there can be such a breakdown of our banking system as has come in the past.

My vision goes even further than this. I see our whole banking and financial and currency systems so coördinated and so delicately adjusted to the demands of business that even severe commercial crises shall likewise be largely avoided. I foresee these systems so highly adapted, so well planned, that they will run on almost automatically. I can see our Federal Reserve System and the currency system that goes with it so developed that when the peace of business gets a little too fast, when American enthusiasm gets out of bounds, when the spell of making money rapidly gets the better of men's judgment, this system will almost automatically apply the brakes. And it will apply them, as I imagine, in time, so that perhaps the very high interest rates which we have at the present will no longer be needed. Perhaps some day a general rise in prices will automatically put a check upon credit expansion. It is conceivable that if we should have had a smooth-acting governor automatically controlling our credit policies, the very rapid rise in prices last year might have been in part, at least, avoided and consequently the quite drastic declines that we are witnessing now.

If, in our financial system, we can get a thorough-going introduction of engineering methods, adapted, of course, to financial and banking problems, I foresee a day when these periods of distress will be nearly if not completely eliminated. And I can see that this will do much more. If we can do away entirely with uninvited unemployment; if we can keep the vast industrial machine running like a wonderful Curtis turbine, day in and day out, year in and year out; if we can get rid of these recurrent times of rising prices which affect so severely the cost of living and breed every kind of friction and irritation and discontent; and if, at the same time, we can get rid of periods of business depression; it seems to me that we ought to do away very largely with the prevalent social disturbances, unrest, and insatiate impulse to try impossible schemes of social betterment.

It ought to be pretty clearly evident that a man on an island can eat and have no more than he reaps and makes. What is true of the man on the island is equally true of a nation of a hundred millions, or of the whole wide world. Throughout the last half century the supply of goods, the total of products in this country, has increased at a rate very close to $4^1/_2$ per cent per annum. Our business crises and depressions have been very largely price cycles—if you like, very largely psychological. The vast business of production has gone on pretty much the same. This is the real foundation, I think, for the hope that the financial and banking engineer of the future may so adjust the credit machine that even these price waves and fluctuations, with their attendant dislocations and disasters, may be largely ironed out.

In brief, gentlemen, I feel that the future is full of the richest sort of promise, financial and social as well as industrial. On the engineering side you have done a great and far-reaching work. You have given American engineers and American engineering the highest place in the world. You have set a wonderful, and, I may say, a difficult example to follow. What I wish you to know is that much the same ideas, much the same aims and methods, are at work now in the development of the Federal Reserve System of the United States.

Address by Samuel Gompers

Because of my high conception of the engineering profession I was glad to accept your invitation to address The American Society of Mechanical Engineers to voice my understanding of the possibilities of your work as engineers of industry, and to suggest what seems to me the responsibility of the engineer to the whole modern industrial system.

One of the difficulties that arises nowadays about our discussion of responsibility is that we fail to realize that professional men, whether doctors, lawyers or engineers, should all be in a very real sense, agents of society and not merely masters in their own particular professions.

We are beginning to realize that just as no nation is isolated from the family of nations, so is it actually true that individually we cannot be isolated from our professions. Every man in his actions, influences in a greater or less degree, other groups or individuals, either for good or evil.

During the past few months engineers have expressed their sense of responsibility in a splendidly stimulating way. In order to accomplish better their purpose of service to others and to contribute to public welfare the best that was in them, all the engineering and technical societies of the United States banded themselves together in a great over-arching organization designated as The Federated American Engineering Societies—a comprehensive organization dedicated to the service of the community, state and nation. This close union makes possible coördination of effort and more efficient progress in achievement of great ideals.

During the past year representatives of engineering organizations as well as individual engineers have come to me, seeking help in getting a better understanding of the human element essential to production and in establishing the proper basis for coöperation with the constructive force which they had come to realize exists in the organizations of human beings engaged in industrial production. For the engineer knows that organization is necessary in order to utilize power—human or material.

It is a tremendously encouraging fact that the engineers throughout the country are coming to appreciate their high calling. It is unnecessary for me to review the mechanical achievements of the engineer, for they speak for themselves, but I do want to point out that concept which has grown up in industry, which many accept, is fundamentally in error. We talk about the production of our factories as being the material, the finished product, in other words, which is sent out in freight cars, and of the individual workmen as by-products. Men, not things, are the true goal of civilization. That civilization fails that does not produce great men and great women, able to create and to use with discrement the material things that serve the spirit. Who can estimate the worth of human beings? I submit that the true ethical point of view of production is that the man himself is the main product and the materials the by-product, and it is in this clearer point of view, it seems to me, the way lies open for joining the forces which the labor movement represents and the forces represented by the activities of your own societies.

The problem involved is not a simple one, for the tendency during the last seventy-five or one hundred years of our western civilization has been to have the machine replace the man. The old feeling of craftsmanship, which existed before the industrial revolution came about, has been greatly modified because of the perfection reached in machine design. This process, however, has been carried entirely too far, for in many places the man has become a human connecting link in a machine and mastered by it instead of controlling the machine himself, as he did with the tools that he used in the old days. The result is that today men's work tends to become mere toil, so it seems to me that the task that lies before us is to develop a definite kind of working environment which will be attractive and which will inspire rather than repulse the workmen. The work itself must become of central concern. This cannot be brought about unless the man finds the opportunity for self-expression in the day's work and a chance to exercise his creative impulses.

During the past 50 years the labor movement has endeavored to protect the workman against the inroads of the machine upon his own life. Our fundamental effort toward this may be epitomized in this declaration. The labor of a human being is not a commodity nor article of commerce. We knew that human labor is inseparable from thinking, living beings, but it took the organized power of our labor organizations to secure recognition of this principle in law and in practice. Workmen's compensation laws and other legislation of a similar nature are a recognition of this fundamental.

I see, however, before the labor movement a great future, as I also see a great future before the engineering profession. If the engineer should join hands with the workman—both devoting their energies to one cause, namely, the development of a kind of industry and a kind of work in which the man will not only learn the processes of production—each day will have increasing opportunities to develop those human functions which are essentially intelligent.

A way has been opened for such coöperation in the declarations of the conventions of the American Federation of Labor, expressing appreciation of the value of the technicians of industry and the desirability of the labor movement's availing itself of scientific aid in all possible ways.

In America our education has been both popular and free. We have had compulsory education for all because we wanted to be sure that all would be prepared for the duties of citizenship. Education, however, is nothing more than the acquiring of greater knowledge of natural law and an opportunity to use this knowledge in the performance of useful work. Is it not logical, therefore, to look forward to the day when our industries will be conducted along educational lines?

It is the deadly monotony of repetitive work that is at the root of most of our troubles, and I, therefore, in the name of the workers, urge you engineers to direct your energies to the solution of this problem. Beware that the machines you create do not become a Frankenstein and enslave the human race.

If you study the laws of humanity with the same degree of intensity that you study the laws of material science, you will render a tremendous service, and as President of the American Federation of Labor it is my firm conviction that the labor movement not only welcomes but invites your coöperation.

Address by William B. Dickson

After a brief introductory statement, Mr. Dickson analyzed the present showing of signs of instability in the social order. Mechanical developments, which during the past two or three generations have advanced the human race, may nevertheless bring about grave dangers, which must be recognized and counteracted if American ideals are to be preserved.

Mr. Dickson spoke of the danger to be apprehended from a high degree of specialization in modern industry and drew a vivid picture of the artisan, happy in the opportunity for the expression of his creative instinct.

In Mr. Dickson's opinion, the menace of people clothed with political power but stunted in body and soul by their industrial environment presents a problem which will need the most careful consideration by the industrial leader.

Mr. Dickson then proceeded as follows:

The principal theme, however, to which I wish to direct your attention is this: What is the supreme issue confronting mankind today? In my opinion, simply the same issue which runs back through all history, and which we have fondly dreamed was settled once and forever by the American people, namely, aristocracy vs. democracy.

We Americans are so accustomed to think of democracy as the normal system of human government, the very flower of civilization, that the man in our midst who would seriously question this apparently self-evident truth would be looked upon as abnormal, to say the least. We fondly hoped that when Cornwallis surrendered at Yorktown political democracy was achieved. As a matter of fact, democracy is not an achievement; it is an opportunity for further struggle upward.

We must now set our minds to the task of applying democratic principles to industrial relations. I believe there is a grave menace to our American ideals in the highly centralized, autocrati control which is becoming a marked tendency in our great industries. The tendency of our modern industrial system is toward autocratic control of the workers through ownership of what our socialistic friends term "the tools of production," which include not only the natural resources, but also the furnaces, mills, factories and transportation systems.

Instead of indulging in glittering generalities, let me cite an instance of what has happened under the existing system of corporate control. Some years ago, a gentleman at the head of one of our great corporations decided that prices must be maintained in the face of a diminishing demand. In order to accomplish his purpose, he restricted production by shutting down a number of large plants located in different communities, each of which had been built up largely as an adjunct of the plant. Some of these plants were kept closed for about a year, and the result was disaster to the communities. The merchants were driven out of business, real-estate values were depreciated, and the workers were thrown on their own resources and had to break up their homes and seek employment elsewhere. None of these persons had any voice in the momentous decision which was made in a New York office, and which resulted in social paralysis in all of these communities.

History is filled with instances where centralized power has led to conditions inimical to human progress, as that term is usually understood in America. It is the effect of the unconscious insolence of conscious power. If we should read in the paper some morning that a Turkish pasha had exercised his authority in such a way as to deprive a city of its means of subsistence, we would raise our eyes in holy horror and bless our good fortune in living in a more enlightened land. Any manifestation of autocracy is repugnant to the American people, whether it proceeds from a president of a corporation, a president of a labor union, or a president of the United States. What is the answer? Only one, namely, industrial democracy.

In a great national crisis, Lincoln said, "A house divided against itself cannot stand;" "this nation cannot continue to exist half slave and half free." I believe that we are approaching a time when we will need an industrial Lincoln, who will give utterance to the creed of the twentieth century; "A house divided against itself cannot stand; this nation cannot continue to exist politically democratic but economically autocratic."

What do I mean by Industrial Democracy? It is exceedingly important that there be no confusion as to this definition. Mr. Carnegie was once asked, "Which is the most important factor in your business, capital, management, or labor?" He replied, "Which is the most important leg on a three-legged stool?" This answer epitomizes my theme, and also what I believe will be the creed of the twentieth century.

In an efficient partnership, such as Mr. Carnegie's answer implied, while each partner may have equal rights, the duties and responsibilities are usually separated so that each exercises his principal functions within his own limited sphere. But where grave questions are to be considered, which vitally affect the organization as a whole, there is general consultation. So, in the new ideal of industrialism, each factor, i.e., capital, management and labor, will continue to have its own separate natural function, as heretofore, but no arbitrary, autocratic decisions affecting the general welfare will be made, either by the directors, the officials, or by the workmen.

Some of you may ask, "Did Mr. Carnegie follow this ideal in practice?" My answer is, "No." He did give a larger measure of recognition to management than most of his fellow-manufacturers, but in his attitude toward labor, he was merely a signpost, pointing the right way but never taking it. The Carnegie labor policy was highly autocratic, as is that of its successor, the U. S. Steel Corporation; a benevolent autocracy, if you please, in many splendid ways, although it still maintains that relic of barbarism, the twleve-hour day. But however large you write the word "benevolent," you must always write after it the word "autocracy." The autocratic policy of this great industrial corporation is diametrically opposed to American ideals, and if it and similar organizations in other industries continue to grow and to maintain this autocratic attitude, there can be only one result—industrial feudalism; feudalism with a high degree of comfort and safety for the worker, I grant you, but none the less, feudalism.

One of the most melancholy tasks of the student of history is to observe the insidious ways in which free institutions have been destroyed under the guise of apparently innocent innovations. Rome, after a glorious history as a republic, extending over nearly five centuries, became an empire under the Caesars, and as far as outward forms were concerned, the transition was so gradual that the citizens did not realize that any real change had occurred. This was so apparent that Julius Caesar himself did not dare to accept the title of king. So today I am not imputing blame to any man or class. No man has deliberately said, even to himself, "I will deprive my fellow-citizens of a large measure of liberty in order to enrich myself," nevertheless the things which lead to this condition have been done, and are being done today as we look on.

As a famous American has said: "The essential characteristic of empire in the objectionable sense, is absolutism. Whether or not absolute power be administered benevolently, makes no difference. The evil is in the power itself, not in the nature or manner of its administration.

When a man, or a number of men, for their own ends, create a great industrial unit, they assume an obligation toward the human elements in that unit, and through them to society in general, which cannot be cancelled or suspended arbitrarily. I subscribe to the doctrine that human labor is not a commodity in the ordinary sense of that term. In a completely natural society, every man by reason of close and continuous contact with land and other natural resources would be an independent, self-sustaining unit. When a man has left this natural condition, whether voluntarily or otherwise, and has become the servant of another man, or other men, he has given up a natural right and his employer has assumed an equivalent obligation. The fact that neither the employer nor the employee has been conscious of this exchange, and that both may have acted from purely selfish motives, does not alter the elemental fact, which, in the great national aggregate, constitutes the great unanswered problem of modern times—the elemental fact that is at the base of all social unrest.

I believe that the greatest task to which American employers must address themselves is the devising of practical ways in which labor can be given the full recognition to which, as an equal partner, it is entitled. I make this statement with absolute confidence in the fairmindedness of the American workingman when he is fully informed and is entirely free to act. If I did not have this confidence, I would despair of the future of our free institutions. I believe, therefore, that one of the first steps necessary to inspire the workman with confidence is the sincerity of the employers recognition of the proper status of labor, in the adoption of a fair system of collective bargaining.

I also believe that in the near future the workmen must become partners through some system of profit-sharing. No scheme could be adopted which would be applicable to all business, as each particular company would have to adopt the general idea to its own particular conditions.

But, some of you may say, "We don't want to have anything to do with your so-called industrial democracy; we are satisfied with the present system and prefer to continue as we are." My answer to this is that the human relations are not static, but dynamic, and unless I am entirely mistaken as to the direction and force of the tide which is now running so strongly in human affairs, your choice will not lie between the present system of industrial control and industrial democracy.

American industry has come to the parting of the ways; on the right, is the road that leads direct to industrial democracy. This road has some heavy grades, and a higher degree of skill will be required to drive on it, but it will bring us out into peace Valley. On the left, is a road also deviating from the old road by which we have come, but it is cunningly camouflaged so as to seem to be the natural continuation of the main highway. It leads directly to industrial feudalism; to that social condition predicted by Hilaire Belloc in his book, The Servile State, in which the workers voluntarily sacrifice freedom in return for comfortable maintenance and safety. From this second road, there is also a by-path which is now being trodden by Russia, and toward which not only our British brethren, but a considerable number of American workmen are being tempted to stray. In other words, the choice lies between democracy on one hand, and serfdom or chaos on the other.

To sum up, what can be done to counteract the tendencies which I have described? These things seem to me to be entirely practicable:

1 Place our industries on a more democratic basis giving recognition to management and labor as, equal partners with capital.
2 Teach democracy in our schools and colleges as thoroughly as we teach arithmetic, so that it will permeate every phase of human life, politically and industrially.

It is a constant source of wonder to me to find so many persons in all walks of life who have no real conception of the vital principles of democracy. Life, in its truest and most virile sense consists largely in making choices, and, like the traveler before the Sphinx, we must answer correctly or be destroyed. I am not looking forward to the new era of industrial democracy as a period of peace and serenity, but rather as a time in which the way has been cleared for a further toilsome climb up the spiral of evolution. I am hopeful that our generation will guess the Sphinx riddle, and that "Out of this nettle, danger, will pluck the flower, safety."

Engineering and Industrial Standardization

A Review of Standardization Work Now in Progress, as Reported by the American Engineering Standards Committee

THE American Engineering Standards Committee held its regular quarterly meeting in New York on October 9. Among the more important reports submitted were those from committees on finance, membership, and safety codes. Nomenclature for standards was also discussed, as well as suggestions for standardization in the zinc and other non-ferrous metal industries. Brief notes from the minutes of the meeting follow:

REPORT OF THE FINANCE COMMITTEE

The report of the Finance Committee, which had been accepted by the Executive Committee and recommended to the Main Committee for approval of the policies therein outlined, had been circulated to the members prior to the meeting. It was accompanied by detailed estimates prepared by the Secretary under instructions of the Executive Committee. The recommendations, in brief, were: (1) That efforts should be made to secure contributions to increase the total annual income of the Committee to $25,000, and (2) that associations of manufacturers rather than individuals or corporations be asked for contributions. These recommendations were very fully discussed, and upon motion by Mr. Robinson it was unanimously resolved that, while it is preferable that contributions be received from associations of manufacturers rather than from corporations, it is entirely proper to accept contributions from corporations provided the appeal for such support be broad enough to include a considerable number of widely different interests, and provided no one company be asked for a relatively large contribution.

REPORT OF THE MEMBERSHIP COMMITTEE

The chairman of the Membership Committee submitted a report recommending favorable action on the applications for membership from the Department of the Interior, the Gas Group, and the American Electric Railway Association. Upon motion by Mr. Latey, it was resolved that the Department of the Interior be admitted to membership with three representatives; that the Gas Group (comprising, at present, the American Gas Association, the Compressed Gas Manufacturers Association, the International Acetylene Association) be admitted to membership with three representatives; and that the American Electric Railway Association be admitted to membership with one representative at the present time, but with the understanding that this may be increased to two or three, if this should later seem advisable. The action in each case was by unanimous vote.

REPORT OF JOINT COMMITTEE ON SAFETY CODES

A report of the chairman of the Joint Committee on Safety Codes dated October 5 was submitted and the four recommendations contained therein were approved by the following unanimous actions to the effect

> (1) That the Bureau of Standards and Society of Automotive Engineers be requested to assume joint sponsorship for an Aviation Safety Code;
>
> (2) That the American Society of Heating and Ventilating Engineers be requested to assume sponsorship for a code on Ventilation;
>
> (3) That the Electrical Safety Conference be designated as sponsor for safety code on Electrical Power Control; and
>
> (4) That in view of the time which has elapsed since the preparation of the 1917 Foundry Safety Code by the American Foundrymen's Association and the National Founders' Association, and of the progress in safety practices in the meantime, that it be suggested to the sponsor bodies that it is desirable to organize a sectional committee to approve or revise this code before it is approved by the American Engineering Standards Committee.

COLOR SCHEMES FOR PIPE LINES

S. J. Williams reported that in accordance with the suggestion of the Executive Committee, The American Society of Mechanical Engineers and the National Safety Council had addressed inquiries to a considerable number of organizations in regard to the desirability of attempting the standardization of color schemes. The answers had all been favorable. Considerable information had already been collected. It was thereupon voted that The American Society of Mechanical Engineers and the National Safety Council be requested to assume joint sponsorship for the standardization of Color Schemes for Pipe Lines.

NOMENCLATURE OF STANDARDS

The following action was taken by unanimous vote:

> WHEREAS, The terms, "Tentative American Standard" and "Recommended American Practice" more accurately express the meaning intended to be conveyed by the terms "Tentative Standard" and "Recommended Practice," and
>
> WHEREAS, The latter terms conflict with long-established practices of important organizations, be it
>
> *Resolved*, That the American Engineering Standards Committee will approve standards as either "Recommended American Practice," "Tentative American Standard," or "American Standard," and will authorize the use of these terms in the publication of standards approved by it.

ZINC AND OTHER NON-FERROUS METALS

A communication was received from the Association Belge de Standardization under date of August 31, suggesting international standardization of the following matters pertaining to zinc: grades of spelter, gage thicknesses and tolerances for sheet zinc, methods of weighing and determining moisture content, and methods of analysis of ore and spelter. The Association also suggested that similar work on other non-ferrous metals might follow.

Mr. Stone stated that he had discussed the matter informally with the American Zinc Institute and that the Institute felt that the work proposed on zinc was very desirable. After further discussion, it was unanimously voted that the American Society for Testing Materials and the American Zinc Institute be requested to assume joint sponsorship for the standardization of zinc.

The larger question raised by the Belgian communication of non-ferrous metals in general, was also considered and it was voted that the officers be authorized to call a conference of the bodies which might be interested, to consider whether work on other non-ferrous metals should be undertaken and if so, what the scope of the work should be.

The Standardization of Elevators

Upon the request of the American Institute of Architects and the Elevator Manufacturers' Association of the United States a conference of the various bodies interested in the question of the standardization of elevators was recently called by the American Engineering Standards Committee for the purpose of deciding whether or not such standardization work should be undertaken, and if so, what its scope should be. The conference was held in New York on September 21, and was attended by representatives of the following organizations:

American Institute of Architects
American Institute of Consulting Engineers
American Institute of Electrical Engineers
American Society of Mechanical Engineers
American Society of Safety Engineers
Bureau of Building (Manhattan)
Bureau of Standards
Electric Power Club
Elevator Manufacturers' Association of New York
Elevator Manufacturers' Association of the United States
National Association of Building Owners and Managers
National Fire Protection Association
Supervising Architect's Office, U. S. Treasury Department

After a full discussion of the subject which touched upon such matters as platform sizes, speeds, accelerations, capacities, methods of test, pit and overhead clearances, well dimensions and hatchways, and safety provisions and appliances, it was unanimously

> *Resolved*, That this Conference fully recognizes the need and the desirability of standardizing such features of both passenger and material-handling elevators as capacities, platform sizes, and methods of test.

The relation of the standardization of the fundamental features of elevator to the Elevator Safety Code now being formulated by The American Society of Mechanical Engineers, was also fully considered, and a committee appointed to confer with the Mechanical Engineers and arrange for coöperation in the completion of this code.

The conference also appointed a committee, consisting of one member from each body represented at the meeting, to develop plans for the standardization of elevators. This committee is to report its recommendations to the American Engineering Standards Committee.

Progress of the Safety Code Program

Considerable progress has been made toward the completion of the program calling for the creation of safety codes. This work has been undertaken by a large number of organizations under the auspices and rules of procedure of the American Engineering Standards Committee, and following the regular procedure, each code is being formulated by a sectional committee, broadly representative of the interests concerned, and composed primarily of representatives designated by the various bodies interested in the particular code. The sectional committee is organized by one or more bodies designated for the purpose by the American Engineering Standards Committee and known as sponsors.

The Head and Eye Protection Code has been completed, and the sponsor, the Bureau of Standards, has submitted the code to the Main Committee for approval. Sponsorships for the additional safety codes have been arranged as follows:

Construction Work. National Safety Council
Electrical Fire Code. National Fire Protection Association
Electrical Safety Code. Bureau of Standards
Floor Openings, Railways and Toe Boards. National Association of Mutual Casualty Companies
Lighting Code. Illuminating Engineering Society
Lightning Protection. American Institute of Electrical Engineers and the Bureau of Standards
Machine Tools. National Machine Tool Builders' Association and the National Workmen's Compensation Service Bureau
Mechanical Transmission of Power. National Workmen's Compensation Service Bureau, the International Association of Industrial Accident Boards and Commissions, and The American Society of Mechanical Engineers
Sanitation Code, Industrial. United States Public Health Service
Stairways, Fire Escapes and Other Exits. National Fire Protection Association
Textiles. National Safety Council and the National Association of Mutual Casualty Companies

SPONSORSHIPS PREVIOUSLY ANNOUNCED

Abrasive Wheels. The Grinding Wheel Manufacturers of the United States and Canada, and the International Association of Industrial Accident Boards and Commissions
Foundries. American Foundrymen's Association and the National Founders' Association
Gas Safety Code. Bureau of Standards and the American Gas Association
Head and Eye Protection. Bureau of Standards
Paper and Pulp Mills. National Safety Council
Power Presses. National Safety Council
Pressure Vessels, Non-Fired. American Society of Mechanical Engineers
Refrigeration, Mechanical. American Society of Refrigerating Engineers
Woodworking Machinery. International Association of Industrial Accident Boards and Commissions and the National Workmen's Compensation Service Bureau

Law for Registration of Engineers

On October 21 the Committee on Licensing Engineers reported to Engineering Council the uniform law for registering architects, engineers and land surveyors. The justification for this law is given in Section 1: "In order to safeguard life, health and property, any person practicing architecture, engineering or land surveying shall be required to submit evidence that he or she is qualified so to practice." The law, as drawn, places no limitations on those who may or may not practice the profession of architecture, engineering or surveying provided they refrain from using the title.

The law specifies in detail the personnel of the Board who shall pass upon the registration of the professions coming under the jurisdiction of the law, providing for apportionment among the professions of architecture, engineering and surveying. All the members of the Board shall be citizens, residents of the state, and members in good standing of recognized professional societies. The Board shall each receive a certificate of appointment from the Governor of the State and a certificate of registration and is then authorized to affix its official seal to certificates of registration granted.

The qualifications for registration are based on a study of the complete statement of the applicant's education and a detailed summary of his technical work. These statements should be made under oath and should be supported by the recommendations of not less than two members of his profession. All applicants to be eligible must be over twenty-five years of age, citizens of the United States or Canada, must speak and write English, must be of good character, and must have been actually engaged for six or more years in architectural, engineering or land-surveying work of a character satisfactory to the Board. A year of teaching or of study satisfactorily completed in a school of satisfactory standing, shall be considered equivalent to one year of active engagement. The functions of the Board are largely administrative and judicial. The burden of presenting evidence of qualifications is placed upon the applicant.

The law states that unless disqualifying evidence be before the Board, the following facts established in the application shall be regarded as prima facie "evidence, satisfactory to the Board," that the applicant is fully qualified to practice architecture, engineering or land surveying:

a Ten or more years of active engagement in architectural, engineering or land surveying work;
b Graduation after a course of not less than four years, in architecture or engineering, from a school or college approved by the Board as of satisfactory standing, and an additional four years of active engagement in architecture, engineering or land-surveying work;
c Full membership in American Institute of Architects, American Institute of Chemical Engineers, American Society of Civil Engineers, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, Society of Naval Architects and Marine Engineers, or such other national or state architectural or engineering societies as may be approved by the Board, the requirements for full membership of which are not lower than the requirements for full membership in the professional societies or institutes named above.

The Board has the power to revoke certificates of registration if the holder be found guilty of negligence, incompetency or misconduct. The law permits practicing in the state by architects, engineers or land surveyors on a consulting basis, provided the non-resident is qualified for professional service in his or her own state or country.

Corporations are permitted to engage in practice under this law, provided the person or persons connected with such corporations or partnerships, in responsible charge of such practice, is or are registered as herein required as architects, engineers or land surveyors.

The law has been prepared by Engineering Council for an act of legislation in each state. Complete copies of the law may be procured of Alfred D. Flinn, Secretary of Engineering Council, 29 West 39th St., New York City.

Warner and Swasey Observatory Dedicated at Case School of Applied Science

The Case School of Applied Science, Cleveland, Ohio, on October 12, 1920, dedicated a new astronomical observatory, the gift of Worcester R. Warner and Ambrose Swasey, partners in the noted firm of instrument makers. The building is placed on the crest of a ridge overlooking a beautiful residential section of Cleveland, about two miles from the school campus. The plan of the building is L-shaped, with the telescope tower at the angle. One single-story wing is devoted to a library and conference room, at the inward end of which is constructed a constant-temperature room for two Riefler clocks. The other wing contains two astronomical transits, and a zenith telescope, all Warner and Swasey instruments. A basement provides living quarters for the caretaker, a storeroom, a battery room, and a photographic room. In the tower is a 10-in. telescope, the lens of which was ground by John Brashear, of Pittsburgh.

At the exercises Mr. Swasey related many anecdotes of the firm's astronomical work, and Mr. Warner, who for thirty years has been a trustee of Case School of Applied Science, presented the keys of the observatory to President Charles S. Howe, who made an appropriate response. Prof. D. T. Wilson, professor of astronomy at Case, outlined his work and his plans for the future usefulness of the observatory. The principal address was delivered by Director W. W. Campbell, of Lick Observatory, Cal., on the topic, The Daily Influences of Astronomy.

Some applications of astronomy to daily life, Dr. Campbell said, are the following: supplying the world with correct time by observations through transits, determining latitudes and longitudes for maps and navigators, the fixing of boundaries and the predicting of tides.

Power Test Codes

A.S.M.E. Committee on Power Test Codes Submits Preliminary Draft of the First of the Nineteen Test Codes Which It Is Formulating

As has been mentioned a number of times in Mechanical Engineering, The American Society of Mechanical Engineers organized in December 1918 a Committee of 125 specialists to revise the Power Test Codes of 1915. This large Committee is subdivided into a Main Committee of twenty-eight engineers which supervises the work of the nineteen Individual Committees. Each Individual Committee, which is made up of from six to ten men, is revising one particular test code.

The Code which follows is entitled "General Instructions," and as its name indicates, has been formulated for use with each of the test codes.

The Committee will welcome suggestions for corrections or additions. These should be sent to Mr. Fred R. Low, Chairman, before January 1, 1921.

GENERAL INSTRUCTIONS

Object

1 Ascertain the object of the test. This object should be kept in view during preparations for the test and in the conduct of the test itself. The methods to be used and the accuracy sought should be in accord with the object in view.

2 Among the many objects of performance tests, the following may be noted:

- Determination of capacity, efficiency or regulation, and the comparison of these with standard or guaranteed results
- Comparison of different conditions or methods of operation
- Analysis and interpretation of plant performance
- Comparison of different kinds of fuel
- Determination of the effects of changes of design or proportion upon capacity or efficiency

3 If questions of fulfilment of contract are involved there should be a clear understanding in writing between all parties as to the operating conditions which should obtain during the trial, the methods of testing to be followed, corrections to be made in case the conditions actually existing during the test differ from those specified, and as to all other matters about which dispute may arise, unless these are already expressed in the contract itself.

Preparations

4 Ascertain and record manufacturer's serial number, plant designation or other means of identifying each unit involved in the test in order that later there may be no uncertainty as to which unit or units were used in obtaining certain data.

5 Examine and record the general features, arrangement and condition of the apparatus and plant, and, if needed, make sketches to show the arrangement, and any unusual features. When making such examinations operating conditions bearing on the object of the test should be noted. So far as possible examination should be internal as well as external.

6 Determine the principal dimensions of the apparatus to be tested, particular attention being given those bearing on the objects in view. When possible, important dimensions should be determined by actual measurement. When conditions of operation change these dimensions, due allowance should be made therefor.

7 If the object of the test is to determine the highest efficiency or capacity obtainable, any physical defects of operation tending to make the result unfavorable should first be remedied. All fouled parts should be cleaned, the whole being put in first-class condition and evidence that it is in such condition should be secured and recorded. If, on the other hand, the object is to ascertain the performance under existing conditions, no such preparation is required or permissible. If fulfillment of contract is involved changes should not be made in apparatus or operation without the consent of all parties interested.

8 In all tests in which the quantity of gas, vapor or liquid flowing in pipes or ducts is determined or in which such quantity forms an item in calculation of results, precautions, must be taken to guard against leakage. Such precautions are necessary in the case of blow-off connections, drips and drains, cross-connections, isolating valves, packing and joints of all kinds, etc. All outlets and inlets other than those actually required in the test should be blanked off or so arranged that any leakage in or out can be observed. A leakage test to determine tightness and to measure unpreventable leaks should be made in every instance.

Instruments and Testing Apparatus

9 The accompanying main code section headed "Instruments and Testing Apparatus" contains a description of the various instruments and appliances which may be employed for Code tests, together with directions for their application, use and calibration, and a statement of their adaptability and limitations. The choice of instruments and apparatus for any test must be determined by local conditions, adaptability and availability, but in all cases the types called for in the various codes should be used. In making this choice, the degree of accuracy desired should be one of the guiding factors.

10 All instruments and testing apparatus used should have designating numbers or other means of identification firmly attached and such identifications should be entered on the log sheets.

11 All instruments and testing apparatus should be calibrated, and any which may give trouble if not approximately correct and all which may be broken in use should be calibrated in advance. Additional calibrated instruments should be provided to replace any which may be broken during the test. Any instrument which may not maintain its calibration throughout a test should be calibrated before and after the test, and, if necessary, at intervals during its progress.

12 The location and arrangement of instruments and apparatus must be left to the judgment and ingenuity of the person in charge, subject to the directions of the code, the details being largely dependent on the type of apparatus under test, the locality and the facilities available. Instruments and testing apparatus should always be so arranged and installed as to give maximum accessibility and best possible illumination in order to facilitate use.

13 Notebooks or log sheets should be so arranged that all readings of one group of instruments or all readings made byo ne observer appear in one book or on one group of sheets. The pages or sheets upon which entries are to be made should be ruled in advance, should be given proper identification marks, should contain space for the date and the name of the observer and should contain proper headings and subheadings. All such sheets should have at least one column in which time is recorded. When rates are to be determined by differences between observations, a time column should accompany the observation column. Space for remarks should be provided on every sheet.

14 A desk or table from which the tests may be directed and at which the records may be assembled should be provided in tests requiring many observers. This should be located with due regard to the positions they occupy. A signal system or a system of intercommunication is convenient and may be provided.

Miscellaneous Instructions

15 The person in charge of a test should have the aid of a sufficient number of assistants, to permit him to give special attention to any part of the work whenever and wherever it may be required. He should make sure that the instruments and testing apparatus continually give reliable indications, and that the readings are correctly recorded. He should also keep in view, at all points, the operation of the plant or part of the plant under test, and see that the operating conditions determined on are maintained and that nothing occurs to vitiate the data.

Starting Conditions

16 When circumstances permit, it is advisable to make one or more preliminary tests for the purpose of determining the adequacy of the instruments and apparatus and of training the personnel. When conditions do not permit such preparatory runs, operations may be started and the time at which conditions become satisfactory can be chosen later as the starting time of the test.

17 Before the test begins or before continuing the test after an important change of conditions during operation, the apparatus should be run under normal conditions for a sufficient length of time to bring about equilibrium with respect to thermal or other factors, except in cases in which the effects of the variation of such conditions are to be determined or included. These exceptions include such effects as result from starting and stopping, carrying units ready for start, and banking fires.

18 In preparation for a test to demonstrate maximum efficiency, it is desirable to make preliminary tests for the purpose of determining the most advantageous conditions.

Operating Conditions

19 In all tests in which the object is to determine the performance under conditions of maximum efficiency, or where it is desired to ascertain the effect of predetermined conditions of operation, all such conditions which have an appreciable effect upon the efficiency should be maintained as nearly uniform during the trial as the limitations of practical work will permit. On the other hand, if the object of the test is to determine the performance under working conditions, no attempt at uniformity should be made unless this uniformity corresponds to the regular practice, and when this is the object the usual working conditions should prevail throughout the trial.

Records

20 Records of a test are divided into two classes:

(*a*) Records of preliminary examination such as those outlined in Paragraphs 4 to 8 inclusive, and

(*b*) Records of observations made, and events occurring during the test.

21 Records of both classes should be made with an original and a sufficient number of carbon copies so that one copy may be given to each party in interest. All records should be signed by the respective observers and countersigned by the person in charge of the test.

22 A log of the observations made during the test should be entered in the notebooks or on the sheets referred to in Paragraph 13. This should be done in such manner that the test may be divided into suitable periods to show the degree of uniformity attained.

23 The readings of instruments from which averages are to be obtained should be recorded at intervals fixed by the extent of their variations. Ordinarily time intervals of from fifteen to thirty minutes are sufficient, but there are cases in which intervals of less than a minute are necessary on account of rapid and irregular variations.

24 Ordinarily the intervals between readings should be regular, and this is particularly true when readings are to be averaged. There are, however, cases in which the purpose of the test is such that regularity is not required and possibly not even desired. In every case the person in charge must determine the requirements in this respect.

25 It is not always necessary to read all instruments at the same intervals, nor is it always necessary to read simultaneously those which are read at the same intervals. In cases in which the readings of given instruments are averaged, respectively, for a long period and these averages are used in calculating results, regularity rather than the attainment of simultaneous readings should be the guiding principle. In cases in which each set of observations is used for calculating a result and the results are then averaged, simultaneous readings are all-important. When observations are made to determine rates by sums or differences, the exact time of making the observation is necessary. Whenever possible, check readings should be made after observation has been recorded.

26 The records made during the test should show the extent of fluctuation of the various instruments in order that data may be available for determining the effect of such fluctuations on the accuracy of the calculated results.

27 A record should never consist of a series of tallies as is sometimes made when loads of given weight are discharged at odd intervals or under similar repeated conditions. In such cases each weight and the time when taken should be recorded.

28 Observations of basic character in a given test should be made and recorded in duplicate by two observers when the importance of the test warrants such precautions. In order that the readings made by these observers may be in accord before it is too late, the readings should be compared and an agreement reached soon after the observations are made.

29 A running graphical log of the principal quantities recorded during a test should be maintained. Such graphical records serve to call attention to undesirable or unintentional lack of uniformity in the conduct of operations and to detect errors of observation or record before it is too late to correct them. Such graphical logs should be arranged so that time is plotted horizontally and quantities vertically.

30 Every event connected with the progress of a test, however unimportant it may appear at the time, should be recorded on the proper log sheets with the time of occurrence and the name of the observer who noted the event and entered the record.

Working up Data

31 It is desirable to work up the data approximately during the progress of the test. This tends to call attention to omissions and to irregularities of various parts. Calculations of this kind are, however, to be regarded as auxiliary testing methods and the results obtained should not be used in the preparation of the final report unless the test is intended to be of approximate nature and the result to be so given.

32 When all records have been completed and assembled, they should be reviewed for the purpose of determining how they are to be used in obtaining the results of the test. All parts of the record which show evident irregularities must be either corrected or eliminated in order that the final results may not be knowingly in error, and if satisfactory adjustments cannot be made, the test must be repeated. All adjustments of this type should be noted and explained in the final report.

33 After reviewing the record, the methods of calculation to be adopted must be decided upon. There are two distinctly different methods available and it is necessary to recognize the conditions under which each may be used. These methods are:

(*a*) The method using primary averages in which all readings of each instrument are averaged for a given period and these averages are then used in calculating final results, and

(*b*) The method using final averages in which the final result is calculated from each set of coincident observations and the final results are then averaged as a grand average.

The choice between these two methods of calculating results should be determined by the type of formula involved and the degree of accuracy desired. When the formula involves the sum or difference of first powers of the observed quantities, either method will give the same numerical results; when the formula involves the product or the quotient of first powers, the two methods will agree quite closely; but when the formula involves fractional powers or powers greater than the first, the method of primary averages will give approximate results only. The error resulting from the use of this method is due to the fact that averages of fractional or multiple powers are not numerically the same as the fractional or multiple powers of averages.

34 When working up the results graphical logs of the principal quantities and of the principal results should be prepared for inclusion in the report. The Report of the Joint Committee on Standards for Graphic Presentation may be used as a general guide.

35 In working out results and in making reports the principles of the theory of errors may be applied to determine what observations should be rejected, the manner of treating the data obtained and assigning the relative importance of various quantities determined.

Report

36 The report of a test of considerable magnitude should be divided into three distinct parts, as follows:

(*a*) Brief statement of object, results, conclusions and recommendations.

(*b*) Complete presentation of the leading facts regarding the entire work.

(*c*) Appendices giving details which are not included in (*b*) such as methods of calculation, methods of calibration, descriptions of special testing apparatus, results of preliminary or special tests, etc.

(*Continued on page 725*)

First Meeting of the American Engineering Council

Thirty Societies Represented—Herbert Hoover Elected President—Engineers of the Nation Now Organized for United Action in Public Service

At the first meeting of the American Engineering Council of The Federated American Engineering Societies at Washington, D. C., November 18 to 20, there was an auspicious beginning of activities by the election of Herbert Hoover as president. Five sessions were held to complete the organization of the Federation which is to unite the engineers of America for service to the city, state, and nation. Delegates were present from 21 member societes having an enrollment of 50,000 engineers, and representatives from the nine organizations which are considering membership. The conference is one of the most important and significant events in the history of engineering and portends a broadening vision and wider field of influence for the engineer.

Herbert Hoover
President of the Federation

The Council voted to establish permanent headquarters at Washington, D. C., and at a meeting of the Executive Board a committee was appointed to nominate a candidate for executive secretary. Until such executive is appointed, Mr. L. P. Alford, formerly secretary of the Joint Conference Committee, is to act as temporary secretary, with headquarters in the rooms of The American Society of Mechanical Engineers at 29 West 39th Street, New York.

Mr. Hoover gave an address on Industrial Relations, an abstract of which appears below. This resulted in a movement for a committee on Industrial Waste to consider problems of human relations in industry and coöperation between labor and capital.

The Opening Session

The call to order was by Richard L. Humphrey, of Philadelphia, Pa., chairman of the Joint Conference Committee. He briefly recounted the history of the movement which resulted in the Federation and of the Organizing Conference last June in which delegates from 72 organizations, representing 100,000 engineers, took part.[1] Since that time he stated, the Joint Conference Committee, which has conducted the affairs of the Federation preliminary to the first meeting of its governing body, has kept in touch with the 116 organizations invited to become members of the Federation and has received replies from all but about 3 per cent of the aggregate membership represented. Of this membership, 35 per cent have accepted the invitation; and, including the participating organizations who have given the matter of membership favorable consideration but as yet have not taken final action, 50 per cent were represented in this first meeting. In other words there were delegates in attendance from 21 societies and representatives from 9 participating societies. The largest delegation was from The American Society of Mechanical Engineers.

Mr. Humphrey also spoke briefly of the opportunities and activities that lay before the Federation and expressed his satisfaction that the keynote of the organization centered around the one word—Service. In this connection he said in part:

> You are embarking on a broad field of activity under the critical but hopeful eyes of the entire engineering and allied technical professions. It, therefore, behooves you to maintain the high ideals and add to the traditions of these professions.
>
> It is highly essential to organize and catalogue the engineering resources of this country, to the end that the engineering and allied technical professions shall not again be lacking in preparedness as they were at the beginning of the late war. The best method should be devised for framing a national engineering policy by which The Federated American Engineering Societies can be instrumental in shaping a program for our great national engineering problems. Furthermore the vital need for constructive suggestions based upon careful study of the great national problems, such as transportation, conservation of labor, water, fuel, and other natural resources, should be met through the work of this organization.

Following the remarks by Mr. Humphrey, E. S. Carman, of Cleveland, delegate of The American Society of Mechanical Engineers, was elected temporary chairman, and W. E. Rolfe, delegate of the Associated Engineering Societies of St. Louis, temporary secretary. Mr. Carman, in taking the chair, declared, in accord with Mr. Humphrey, that the keynote of the new organization was embodied in the word "service" and expressed the hope that its aim would always be toward the highest pinnacle.

Resolutions were next passed expressing sincere regret that Mr. Humphrey, who had labored so faithfully for the Federation, and his colleagues of the American Society of Civil Engineers, were not permitted to participate officially.[1] The delegates very graciously accorded the privilege of the floor to these gentlemen by a rising vote.

The meeting then considered the question as to what organizations should be considered charter members and it was voted that all organizations to which invitations had been sent to join the Federation should be considered charter members if acceptances were received by July 1, 1921.

The following temporary committees were then appointed and were instructed to report at the next morning's session: Program, Credentials, Constitution and By-Laws, Nominations, Plan and Scope, Budget, and Resolutions.

L. P. Alford next took the floor and announced the representation on the Executive Board in accordance with the constitution to be by districts for local societies (one delegate from each district) and on the basis of membership for the national societies. The country for the present is to be divided into six districts, as follows: (1) New England and New York State; (2) Minnesota, Wisconsin, and Michigan; (3) Illinois, Indiana, and Ohio; (4) Pennsylvania, New Jersey, Maryland, and Delaware; (5) States south of the Ohio River and east of the Mississippi, and Texas, and Louisiana; (6) States west of the Mississippi, with the exception of Minnesota, Texas, and Louisiana.

This division allows six representatives from local organizations and 14 from the national societies which are now members of the Federation, the latter number being divided as indicated by the number in parentheses which follows the names of the national societies listed below.

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[1] See Mechanical Engineering, July 1920.

[1] **By a recent letter ballot the American Society of Civil Engineers voted against joining the Federation.**

The remainder of the morning session was devoted to a discussion of the location of the Federations' headquarters. Consideration was given to the advantages of locations geographically central and at or near the industrial center of the country; and to the relative advantages of New York, where is located the headquarters of the national engineering societies, and of Washington, D. C. New York from the start was practically counted out. It was considered by many speakers that while there were evident business reasons for selecting New York City, the national character of the organization would be better emphasized by locating elsewhere. Many favored Washington. Besides the governmental departments with which the Federation would need to be in close communication in respect to engineering matters of national importance, Washington is already the headquarters of many organizations of prominence and with whom conference would be needed.

Objection to Washington was that its selection might lead to the impression that the Federation was organized for political purposes and that its officers were engaged in lobbying and other undesirable practices. Nevertheless the trend of opinion was that Washington was the most favorable point for contact with those engaged in promoting the best interests of the nation and in rendering service of various kinds to the citizens of the country. In none of the discussions was a geographically central location for headquarters considered as more than of secondary importance, since it would merely affect the convenience of delegates traveling to headquarters and in so far as the operation of the executive staff is concerned might result in less effective work. In any case it was considered essential that there should be a Washington office.

At the conclusion of this discussion, Philip N. Moore of St. Louis offered a resolution, with the proviso that it be laid on the table for discussion at the afternoon session, that it be the sense of the meeting that the headquarters of the Federation be located in Washington, D. C. This motion was duly seconded, whereupon the morning session was adjourned.

The Afternoon Session

The afternoon session, beginning at two o'clock, was opened by an address on Engineering Council by J. Parke Channing of New York. Mr. Channing has served as chairman of the Council for the past three years and his remarks as to the work accomplished during that time and the tasks before the new American Engineering Council were largely in the nature of recommendations and warnings to the new body. Speaking of the accomplishments of the old Engineering Council, Mr. Channing said in part:

> During the war we furnished the Government with the names of 4000 engineers for war service. We aided the Naval Consulting Board and the Army General Staff in examining 135,000 suggestions and inventions for war devices. We assisted the Fuel Administrator and the Bureau of Mines. We supplied Congress with information about waterpower.
>
> On January 1, 1919, we opened an office in Washington giving varied service to engineers, and have also aided the Government in engineering matters.
>
> In April, 1919, we called a conference at Chicago of seventy-four technical organizations having 105,000 members. This conference is permanently organized and is advocating the establishment of a National Department of Public Works.
>
> Through an appeal to the President, we have brought together a conference of fourteen Government offices engaged in map making, with prospects of getting under one head the completion of the topographical map of the United States.
>
> We now have a Classification and Compensation Committee of Engineers, with sections on Railways, Federal Government, Municipal and State Governments, and we are working in harmony with the Congressional Joint Committee on Reclassification of Salaries.
>
> We have just drafted a typical law for the registration of engineers and we have joined with the National Research Board in a report on an improvement of the patent system as a result of which legislative action is being taken.

Member-Societies and Representatives at the First Meeting of American Engineering Council

Washington, D. C., November 18–19, 1920

Alabama Technical Association, Birmingham, Ala.
Paul Wright, Birmingham, Ala.

American Institute of Chemical Engineers, Brooklyn, N. Y. (1)
Allerton S. Cushman, Washington, D. C.
* Harrison E. Howe (*alternate*), Washington, D. C.

American Institute of Electrical Engineers, New York, N. Y. (4)
* Calvert Townley (*chairman*), New York, N. Y.
Comfort A. Adams, Cambridge, Mass.
A. W. Berresford, Milwaukee, Wis.
* H. W. Buck, New York, N. Y.
F. L. Hutchinson, New York, N. Y.
W. A. Lyman, St. Louis, Mo.
* William McClellan, Philadelphia, Pa.
L. F. Morehouse, New York, N. Y.
Lewis T. Robinson, Schenectady, N. Y.
Charles S. Ruffner, New York, N. Y.
* Charles F. Scott, New Haven, Conn.
* Lewis B. Stillwell, New York, N. Y.

American Institute of Mining and Metallurgical Engineers, New York, N. Y. (3)
* Herbert Hoover, Palo Alto, Calif.
* J. Parke Channing, New York, N. Y.
Arthur S. Dwight, New York, N. Y.
Edwin Ludlow, New York, N. Y.
Allen H. Rogers, Boston, Mass.
Philip N. Moore, St. Louis, Mo.
John V. W. Reynders, New York, N. Y.
Joseph W. Richards, Bethlehem, Pa.

American Society of Agricultural Engineers, Ames, Iowa (1)
Samuel H. McCrory, Washington, D. C.

American Society of Mechanical Engineers, New York, N. Y. (4)
* L. P. Alford (*chairman*), New York, N. Y.
Charles T. Main, Boston, Mass.
* Arthur M. Greene, Jr., Troy, N. Y.
* E. S. Carman, Cleveland, Ohio.
Arthur L. Rice, Chicago, Ill.
* Dexter S. Kimball, Ithaca, N. Y.
Paul Wright, Birmingham, Ala.
W. A. Hanley, Indianapolis, Ind.
William B. Gregory, New Orleans, La.
V. M. Palmer, Rochester, N. Y.
H. P. Porter, Tulsa, Okla.
Robert H. Fernald, Philadelphia, Pa.
L. C. Nordmeyer, St. Louis, Mo.
* Fred J. Miller (*alternate*), Centre Bridge, Pa.
Robert Sibley (*alternate*), San Francisco, Calif.
Charles Whiting Baker (*alternate*), New York, N. Y.

Associated Engineering Societies of St. Louis, Mo.
* William E. Rolfe, St. Louis, Mo.

Detroit Engineering Society, Detroit, Mich.
D. J. Sterrett, Detroit, Mich.

Engineering Association of Nashville, Tenn.
C. B. Howard, Nashville, Tenn.

Engineering Society of Buffalo, N. Y.
W. B. Powell, Buffalo, N. Y.

Grand Rapids Engineering Society, Grand Rapids, Mich.
Burritt A. Parks, Grand Rapids, Mich.

Kansas Engineering Society, Topeka, Kan.
* Lloyd B. Smith, Topeka, Kan.

Louisiana Engineering Society, New Orleans, La.
William B. Gregory, New Orleans, La.

Mohawk Valley Engineers' Club, Utica, N. Y.
Byron E. White, Utica, N. Y.

Technical Club of Dallas, Tex.
* O. H. Koch, Dallas, Tex.

The Cleveland Engineering Society, Cleveland, Ohio
* John F. Oberlin, Cleveland, Ohio.

The Engineers' Club of Baltimore, Md.
W. W. Varney, Baltimore, Md.

The Society of Industrial Engineers, Chicago, Ill. (1)
* L. W. Wallace, Baltimore, Md.

Washington Society of Engineers, Washington, D. C.
E. C. Barnard, Washington, D. C.

York Engineering Society, York, Pa.
William J. Fisher, York, Pa.
H. A. Delano (*alternate*), York, Pa.

* *Present Members of Executive Board*

> This shows the general lines along which we have been working and I would suggest that the new American Engineering Council follow in a general way such lines. You will find that you will have to be most rigorous in determining what activities you may undertake and will have to turn down many suggestions which you will find are beyond the province of your Council.
>
> Organized as you are with a broader support than Engineering Council, you will be able to make recommendations on state and local questions through local societies which are members of your body. But you must be careful and not permit yourself to be used for movements which however good in themselves are not especially under the perview of engineers.

Following Mr. Channings' address the chair called upon Alfred D. Flinn, secretary of Engineering Council, Philip N. Moore, and Dr. D. S. Jacobus to express their views as to the field of activity of the Federation. Mr. Moore and Dr. Jacobus have both been active in the work of Engineering Council and Mr. Flinn has served as secretary of the body for the past four years. Their remarks were accordingly received with great interest by the delegates assembled. It was their chief and unanimous opinion that the new American Engineering Council should carry on the work begun by the old Council extending it so as to cover a wider field and thus be of greater service to its member societies and in turn to the individual members. New lines of endeavor would soon develop they also asserted but as to participation in all of these they counseled careful thought before decisions were reached.

Following this discussion the motion of Mr. Moore relative to the location of the headquarters of the Federation, in accordance with the decision of the morning session, was next taken from the table. It was further discussed along the lines followed in the morning. An amendment was finally made to refer it to the Executive Board with power to act. This however was defeated and upon the original motion being put 29 delegates voted in favor and six against. This decision, which thus locates the headquarters of the Federation at the National Capitol, concluded the sessions of the first day.

The Friday Morning Session

The Friday session opened at nine o'clock with E. S. Carman, temporary chairman presiding. The chair first announced that the Taylor Society had voted to join the Federation and that their delegate, Morris L. Cooke, was present to take part in the proceedings. The Taylor Society is the twenty-first society to join the Federation.

L. W. Wallace, president of the Society of Industrial Engineers, next addressed the Council on the subject of Labor Conservation. He stressed the importance of safety and welfare work and the necessity of medical advisors in the attainment of such conservation. He also discussed the need of industrial education not alone, as he stated, for the worker but for all, even including the chief executives. Our labor problems, he declared, can only be solved by the earnest coöperation of both employer and employee.

Following Mr. Wallace the Nominating Committee offered its report and at the request of its chairman, D. S. Kimball put before the Council the choice of the committee for president—Herbert Hoover. In his introduction Dean Kimball said that it was important to the profession and the country at large that the standing of the men in the Council should be gaged by their standing among their brothers and that there was one who was thus preëminent. Later he added, "You have elected a statesman, not an engineer."

The list of officers follows:

President

Herbert Hoover, Am. Inst. M. & M. Eng.

Vice-Presidents

Calvert Townley, Am. Inst. Elec. Eng. (2 year term)
W. E. Rolfe, Assoc. Eng. Soc. of St. Louis (2 year term)
D. S. Kimball, Am. Soc. Mech. Eng. (1 year term)
J. Parke Channing, Am. Inst. M. & M. Eng. (1 year term)

Treasurer

L. W. Wallace, Soc. of Ind. Eng.

After formal vote had been taken, Mr. Hoover, was escorted to the platform and took the chair. He briefly expressed his appreciation of the action of the Council and then withdrew for a short time to attend a meeting of the Red Cross which was holding a simultaneous session. In his absence Calvert Townley presided and brief acceptance speeches were next made by all the newly elected officers.

The morning session closed with the presentation of the report of the Committee on Constitution and By-Laws, recommending several minor changes in both the Constitution and By-Laws, but of such a character as not to change the import of their main provisions. The changes were discussed and voted upon item by item.

The Closing Session

The closing session of the Council on Friday afternoon saw Mr. Hoover in the chair. The announcement was first made of the members constituting the Executive Board (see page 721) and this was followed by the report of the Committee on Plan and Scope. This report in the main followed the recommendation made by J. Parke Channing in his address at the opening session. It pointed out in particular the importance of service to state and nation by investigation and advice strictly along non-partisan lines, and the necessity of maintaining contact with the local and regional engineering organizations.

Calvert Townley, as chairman of the Budget Committee, next submitted a tentative budget for the Council's consideration. He explained that if the Federation should not add to its member-societies during the year the estimated income would be $59,000 but if the societies who have already made known their desire to join the Federation should do so then an income of $80,000 might be expected. With these minimum and maximum figures in mind the estimated expenses for the maintenance of the organizations' headquarters, for committee expenses, traveling expenses, etc., would be $56,500 as a minimum and $93,500 as a maximum. The report was accepted and referred to the Executive Board for further consideration.

This concluded the official business of the day but prior to adjournment the Council was addressed by Geo. G. Anderson of Los Angeles, Cal. who told of the results of coöperation among the engineers on the western coast. Much has been accomplished he said, through joint effort and he urged that other states organize local engineering councils.

Address by Herbert Hoover

On Friday evening, November 19, a large audience gathered to listen to an address by Herbert Hoover, president of the Federation, on some Phases of Relationship of Engineering Societies to Public Service. Referring to the great problems which have come as a result of the industrial development of the past fifty years, and the inadequacy of socialism to solve them he said in part:

> We have built up our civilization, political, social and economic, on the foundation of individualism. We have found in the course of development of large industry upon this system that individual initiative can be destroyed by allowing concentration of industry and service and thus an economic domination of groups over the whole. We have therefore built up public agencies intended to preserve an equality of opportunity through control of possible economic domination. Our regulation of public utilities and of many other types of industry, aiming chiefly to prevent combination in restraint of free enterprise, is a monument to our attempts to limit this economic domination—to give a square deal. While our system of individualism under controlled capitalism may not be perfect, the alternative offers nothing that warrants its abandonment. Our thought, therefore, needs to be directed to the improvement of this structure and not to its destruction.
>
> A profound development in our economic system, apart from control of capital and service during the last score of years, has been the great growth and consolidation of voluntary local and national associations. We have the growth of great employers' associations, great farmers' associations, great merchants' associations, great labor associations—all economic groups striving by political agitation, propaganda, and other measures to advance group interest. At times they come in sharp conflict with each other and often enough charge each other with crimes against public interest. And to me, one question of the successful development of our economic system rests upon whether we can turn the aspects of these great national associations towards coördination with each other in the solution of national economic problems, or whether they grow into groups for more violent conflict.
>
> The Federated American Engineering Societies stands somewhat apart among these great economic groups, in that it has no special economic interest for its members. Its only interest in the creation of a great national association is public service, to give voice to the thought of the engineers in these questions. And if the engineers with their training in quantitative

thought, with their intimate experience in industrial life, can be of service in bringing about coöperation between these great economic groups of special interests, they will have performed an extraordinary service. The engineers should be able to offer expert service in constructive solution of problems to the individuals in any of these groups. And here is a wider vision of this expert service in giving the group service of engineers to group problems.

One of the greatest conflicts rumbling in the distance is that between the employer on one side and organized labor on the other. We hear a great deal from extremists on one side about the domination of organized labor. Probably the tendency to domination exists among extremists on both sides. One of the most perplexing difficulties in all discussion and action in these problems is to eliminate this same extremist. There are certain areas of conflict of interest, but there is between these groups a far greater area of common interest, and if we can find measures by which, through coöperation, the field of common interest can be organized, then the area of conflict can be in the largest degree eliminated.

In this connection the employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers, and yet the labor organizations, as they stand today, are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possible initiative on the part of the employer; and further, that in the long run we can only expand the standard of living by the steady increase of production and the creation of more goods for division over the same numbers.

The American Federation of Labor has publicly stated that it desires the support of the engineering skill of the United States in the development of methods for increasing production and I believe it is the duty of our body to undertake a constructive consideration of these great problems and to give assistance, not only to the Federation of Labor, but also to the other great economic organizations interested in this problem, such as the Employers' Association and the Chambers of Commerce.

It is primary to mention the three-phase waste in production: First, from intermittent employment, second, from unemployment that arises in shifting industrial currents and third, from strikes and lockouts. Beyond this elimination of waste, there is another field of progress in the adoption of measures for positive increase in production.

In the elimination of the great waste and misery of intermittent employment and unemployment, we need at once coördination in economic groups. For example, our engineers have pointed time and again to the bituminous coal industry, where the bad economic functioning of that industry results in an average of but 180 days' employment per annum, where a great measure of solution could be had if a basis of coöperation could be found between the coal operators, the coal miners, the railways, and the great consumers. The combined results would be a higher standard of living to the employees, a reduced risk to the operator, a fundamental expansion of economic life by cheaper fuel. With our necessary legislation against combination and the lack of any organizing force to bring about this coöperation, the industry is helpless unless we can develop some method of governmental interest, not in governmental ownership, but in stimulation to coöperation in better organization.

In help against the misery in the great field of seasonal and other unemployment, we indeed need an expansion and better organization of our local and federal labor exchanges. We have a vast amount of industry, seasonal in character, which must shift its labor complement to other industries. The individual worker is helpless to find the contacts necessary to make this shift unless the machinery for this purpose is provided for him.

In the questions of industrial conflict resulting in lockout and strike, one mitigating measure has been agreed upon in principle by all sections of the community. That is collective bargaining, by which, wherever possible, the parties should settle their difficulties before they start a fight. It is founded not only on the sense of prevention but on the human right to consolidate the worker in a proper balanced position to uphold his rights against the consolidation of capital. This measure, advocated for long years by organized labor, was agreed to by the employers group in the First Industrial Conference. It has been supported in the platform of both political parties. The point where the universal application of collective bargaining has broken down is in the method of its execution. The conflict arises almost wholly over the question of representation and questions of enforcement. The employer in some industries denies the right of men other than his own employees to conduct the negotiations. Labor organizations demand that, as such negotiations require skill, experience and bargaining freedom, they are of more than local application and that thus they only can protect the body of workers by presenting the case on their behalf by skilled negotiators.

The Second Industrial Conference, of which I was a member, proposed a solution to this point by the provision that where there was a conflict over the determination representation should be left to a third party. It also proposed that each party should have the right to summon skill and experience to its assistance. It further proposed that where one of the parties at dispute refuses to enter upon collective bargaining, the entire question should be referred to an independent tribunal for investigation as to the right and wrong of the whole dispute—but only for investigation and report. The conference was convinced that the illumination of the public mind as to the rights and wrongs of these contentions would in itself make for material progress in their solution and that in public education and the condemnation by public opinion of wrong doing lay the root to real progress. The conference did not believe that industrial contention could be cured by compulsory arbitration or any other form of governmental repression.

There are questions in connection with this entire problem of employer and employee relationship, both in its aspects of increased production and in its aspects of wasteful unemployment, that deserve most careful study by our engineers. There lies at the heart of all these questions the great human conception that this is a community working for the benefit of its human members, not for the benefit of its machines or to aggrandize individuals; that if we would build up character and abilities and standard of living in our people, we must have regard to their leisure for citizenship, for recreation, for family life. These considerations, together with protection against strain, must be the fundamentals of determination of hours of labor. These factors being first protected, the maximum production of the country should become the dominating purpose. There is a broad question bearing upon stimulation of self-interest and thus increase in protection that revolves around the method of wage payment. I need not review the advantages, difficulties and weaknesses of bonus, piece-work, profit or saving sharing plans that are in use as a remedy for the deadening results of the same wage payment to good and bad skill alike. The suggestion I wish to put for your consideration is the possible use of another device in encouragement of individual interest and effort by creating two or three levels of wage in agreement for each trade, the position of each man in such scale to be based upon comparative skill and character. This plan should be developed upon the principle of extra graded compensation for added skill and performance, above an agreed basic wage. In order to give confidence, the classification under such scales must be passed upon by representatives of the workers in each shop or department. This plan is now being successfully experimented with.

We must take account of the tendencies of our present repetitive industries to eliminate the creative instinct in its workers, to narrow their field of craftsmanship, to discard entirely the contribution to industry that could be had from their minds as well as from their hands. Indeed, if we are to secure the development of our industries, we could not accomplish increased production without their stimulation. Here again we cannot make an advance unless we can secure coöperation between employer and employee. In large industry this mutuality of interest that existed in small units cannot be restored without definitive organization.

[Mr. Hoover here discussed shop committees as a system of such organization, saying that if organized labor should settle its problems of wage and conditions of labor in general agreement and apply its energies through shop committee organization to development of production as well as to the correction of incidental grievance, another step in coöperation would be accomplished —Editor.]

There is an immediate problem in increased production that is too often overlooked by the theorist. While it is easy to state that increased production will decrease cost and by providing a greater demand for goods secure increased consumption and ultimate greater employment, yet the early stages of this process do result in unemployment and great misery. We usually accomplish these results over long periods of time, but if we would secure coöperation to accomplish them rapidly we must take account of the unemployment and we must say to the community that if it is to benefit by the cheapening costs and thus the increased standard of living, or alternatively if the employer is to take benefits, the entire burden should not be thrust upon the individual who now alone suffers from industrial changes.

In summary, the main point that I wish to make is this, that there is a great area of common interest between the employer and the employee through the reduction of the great waste of voluntary and involuntary unemployment, and in the increase of production. If we are to secure increased production and an increased standard of living, we must keep awake interest in creation, in craftsmanship, and the contribution of the worker's intelligence to management. Battle and destruction are a poor solution to this problem. The growing strength of national organizations on both sides should not be and must not be contemplated as an alignment for battle. Battle quickly loses its rules of sportmanship and adopts the rules of barbarism. These organizations—if our society is to go forward instead of backward—should be considered as the fortunate development of influential groups through which skill and mutual consideration can be assembled for coöperation to the solution of these questions. If we could secure such coöperation, throughout all our economic groups, we should have provided a new economic system, based neither on the capitalism of Adam Smith nor upon the socialism of Karl Marx. We should have provided a third alternative that preserves individual initiative, that stimulates it through protection from denomination. We should have given a priceless gift to the twentieth century.

Meeting of the Executive Board

The Executive Board, charged with conducting the business of the Federation under direction of the American Engineering Council, held its first meeting on Saturday morning. In the absence of President Hoover, Vice-President Rolfe presided. Charles F. Scott served as secretary.

The first business was the appointment of a committee to recommend a candidate or candidates for Executive Secretary of the American Engineering Council. Following a discussion Dean D. S. Kimball said he had given the matter much thought and without having consulted others would suggest five names representative of the various interests concerned in the conduct of the affairs of the Council. It was understood that President Hoover would act ex-officio. These names were:

W. W. WALLACE, Baltimore, *Chairman*, representing the officers of the Council.
PHILIP N. MOORE, St. Louis, representing A.I.M.E.
CHARLES F. SCOTT, New Haven, representing A.I.E.E.
L. P. ALFORD, New York, representing A.S.M.E.
JOHN F. OBERLIN, Cleveland, representing the local societies

It was voted that this committee be appointed, with the addition of the name of Calvert Townley, representing the present Engineering Council, thus constituting with the president, a committee of seven to report at the next meeting.

The question of whether assessments upon member societies should be on the basis of voting membership or of total membership in these societies, was referred to the Committee on Membership and Representation.

The Board declared in favor of continuing the efforts of Engineering Council for a National Department of Public Works. This led to a general discussion of ways and means which could properly be adopted by the Federation for the promotion of public and legislative matters. Maj. Fred J. Miller spoke in opposition to spending money for promotion and to lobbying in any form. He advocated the formulation of policies by the Council and the use of publicity methods to bring them to the attention of legislators and the public. L. B. Stillwell referred to the last French Engineering Congress, held at Paris, as exemplifying a way in which this could be done. Committees were appointed to present reports to the Congress on such public questions as highways, hydraulics, etc., and when formally accepted the reports at once became available for incorporation in legislation and carried with them the prestige of the Congress.

The Board indorsed the plan, previously suggested by President Hoover, for a committee to investigate industrial waste and authorized the president to organize for this purpose. The committee will be the agency through which the Council will take up the question of industrial relations and the losses incident to the lack of coöperation between capital and labor.

It was voted that the establishment of Washington headquarters, as directed by vote of the Council, should be deferred until the appointment of the permanent Executive Secretary, probably in January. To provide for carrying on the current work, and particularly the preparation and distribution of the minutes of the present series of meetings, L. P. Alford was elected temporary secretary with headquarters in the rooms of The American Society of Mechanical Engineers, New York, to serve until the next meeting of the Board.

The last action of the Board was to request The American Society of Mechanical Engineers to give Mr. Alford such assistance on the part of its staff as might be required to conduct temporarily the work of the Federation.

NEWS OF THE ENGINEERING SOCIETIES

Conventions of the American Foundrymen's Association, the American Iron and Steel Institute, and the American Electrochemical Society

American Foundrymen's Association

THE annual convention and exhibition of the American Foundrymen's Association took place at Columbus, Ohio, on October 4 to 8. At the technical sessions 67 papers were scheduled, most of which were presented. There were 240 exhibitors and the registered attendance exceeded 3800. An outstanding feature of the convention was the announcement of five donations, four of $5000 each and one of $1000, the income from which will be awarded in recognition of meritorious work in foundry research and invention.

Dr. Richard Moldenke, Watchung, N. J., presented a paper on the elements useful for purifying cast iron, with special reference to zirconium.

A paper on the electric furnace and the problem of sulphur in cast iron was read by George K. Elliot, Lunkenheimer Co., Cincinnati. The tendency of sulphur to segregate, he said, constitutes the greatest menace of high sulphur, but he claimed that it is impossible to fix positively any pronounced advantage in iron with 0.015 or 0.030 per cent sulphur over those with twice that amount. Instead of striving for low sulphur limits the speaker was of the opinion that the use of more scrap or of pig iron running comparatively high in sulphur will become popular. A. N. Kelly, Modern Tool Co., Cincinnati, described the methods employed in the production of machine-tool castings. This paper was illustrated with lantern slides showing the methods employed in the work.

A paper describing the making of high-grade iron castings for milling-machine tables at the plant of the Brown & Sharpe Mfg. Co., Providence, R. I., was read by Leroy Sherman. Papers were also read by E. J. Fowler, San Francisco, on Standardizing Gray-Iron Castings for Analytical Determination; Electrical Apparatus in a Modern Iron Foundry, by F. W. Egan, Pittsburgh; The Foundry of the U.S.S. *Prometheus*, prepared by Lieut. R. F. Nourse; and Approved Methods of Testing Molding Sands, by S. W. Stratton, of the U. S. Bureau of Standards, Washington.

The need for developing standards for molding materials was emphasized and a number of tests for determining the usefulness of sand and clay in the shop were discussed by R. L. Lindstrom, Canadian Steel Foundries, Montreal.

The status of the electric furnace in the steel industry as of September 1, 1920, was surveyed by Edwin F. Cone, associate editor, *The Iron Age*, New York. There were in the United States and Canada on January 1, 1920, 363 furnaces of all types operating or contracted for in the steel industry; on September 1, this figure had been expanded to 374 or a net increase of 11 furnaces. This increase was wholly in the United States.

Annealing Steel with Pulverized Coal was the title of a paper by C. H. Gale, Pressed Steel Car Company, McKees Rocks, Pa. The author stated that where the investigations were conducted a marked difference in the physical characteristics of steel was noticed after pulverized coal was substituted for gas and oil for the annealing furnaces. The tensile strength became greater and the carbon and sulphur content was increased.

Other steel foundry papers were: Cleaning Steel Castings, by A. W. Gregg; Electric Heat Treating of Steel Castings, by E. F. Collins; Making Acid Electric Steel, by James W. Galvin and Charles N. Ring; Making Steel Castings to Specifications, by E. R. Young, Jr.; and Accurate Treatment of Steel Castings, by T. F. Baily, Alliance, Ohio.

Interesting papers on malleable iron were also presented. Enrique Touceda, Albany, described some experiments made with air furnaces, and suggested some changes in open-hearth furnaces for malleable iron. He stated that future advancement in the malleable-iron industry must come through an improvement in plant organization and metallurgical apparatus. Fractures and Microstructures of American Malleable Cast Iron was the subject of a paper by W. R. Bean, H. W. Highriter and E. S. Davenport, Eastern Malleable Iron Co., Naugatuck, Conn. Two papers by H. A. Schwartz, National Malleable Castings Co., Cleveland, described the new research department of that plant, and also the triplex process for making electric-furnace malleable. E. J. Lowry, Oliver Chilled Plow Co., South Bend, Ind., presented a paper on Practical Malleable Annealing.

These notes have been prepared from the extensive account of the convention published in *The Iron Age* for October 14.

American Iron and Steel Institute

The American Iron and Steel Institute held its eighteenth annual convention in New York on October 22. In his presidential address, Judge Elbert H. Gary, recounted his personal observations in a recent tour through France and Belgium, and predicted speedy recovery by both these nations from the effects of the ravages of war upon industries. In general he took an optimistic view of industry, both abroad and at home.

The technical papers were of the usual high standard. E. A. Wheaton, superintendent, open-hearth department, Bethlehem Steel Co., presented the results of experiments conducted to determine the effect of using a high-manganese iron in the initial basic open-hearth charge. A furnace was operated exclusively on high-manganese iron for a considerable period. The records obtained show that high-manganese iron improves the quality of open-hearth steel without reduction of tonnage or any other injurious effects, and that it is of great assistance in meeting the demands for the better grades of alloy steels. Mr. Wheaton concluded from his data that it is possible, with high-manganese iron, to run lean slags, maintain tonnage, and with sulphur in blast-furnace iron as high as 0.1 per cent to deliver that same iron to the open-hearth furnaces through a mixer with 50 per cent of the sulphur eliminated.

D. M. Buck, metallurgical engineer, American Sheet & Tin Plate Co., Pittsburgh, reviewed the development of copper steel and its non-corrosive properties. Practice has shown that the best results are obtained by alloying with normal open-hearth or bessemer steel, from 0.15 to 0.30 per cent of pure copper. Mr. Buck pointed out that although references are found as early as 1627 to the effect of copper on the physical properties of iron and steel, nothing is found pertaining to the control of corrosion previous to the present century. The relative corrosive properties of untreated and copper-treated iron and steel have been investigated by several authorities from 1900 on. Tests conducted by the American Society for Testing Materials have shown that the life of sheet metal is more than doubled by the copper treatment.

The successful development of the large-hearth blast furnace in the United States was surveyed by Walther Malhesius, superintendent of blast furnaces, Illinois Steel Co., South Chicago, Ill. Hearth dimensions have been increased over the accepted standard without interfering with the height or angle of bosh. The average hearth diameter of all 22-ft. bosh furnaces at the South Chicago plant of the Illinois Steel Co. was increased from 16$^1/_2$ ft. in 1911 to 18$^1/_2$ ft. in 1919. The best average monthly production of these furnaces equaled 512 tons per furnace per day in December 1911, as against 556 tons in May 1920. Mr. Mathesius attributed the increased output to the adoption of the larger hearths, as no enlargement of the furnaces or important changes of lines above the bosh were made. The fuel consumption per ton of iron for the two periods cited above were 2053 lb. in December 1911, and 2037 lb. in May 1920. Further proof of the successful operation of the larger hearth has been furnished by the operation for some time of a furnace with a hearth diameter of 20 ft. 9 in. This furnace was described at length by Mr. Mathesius, and he presented tables of its performance as well as of the average results of other South Chicago furnaces. The furnace with a 20-ft. 9-in. hearth has consistently worked with a more regular and uniformly lower blast pressure than the other furnaces under comparative conditions. Contrary to what has been claimed as to a large hearth requiring an increase in the number of tuyeres, the furnaces at the South Chicago works have worked well with distances between tuyeres of 4 ft. 7$^3/_4$ in., 4 ft. 11$^3/_4$ in.; 5 ft. 9$^3/_4$ in., 5 ft. 10$^5/_8$ in., and 6 ft. 6$^1/_4$ in., the last figure corresponding to the furnace with the 20-ft. 9-in. hearth. The enlargement has not imposed additional or increased stresses and duties, while in some respects the demands upon the strength and wearing qualities have actually lessened. Mr. Mathesius pointed out that the successful development of the large-hearth blast furnace, unhampered by any sacrifice of former advantages, is an exclusively American accomplishment, which is evoking the keenest interest abroad.

F. L. Toy, superintendent of open hearths, Homestead Works, Carnegie Steel Co., surveyed the practice in the manufacture of basic open-hearth steel. He referred specially to the improved devices and methods which have been developed for preserving and lengthening the life of the furnace, and discussed in detail the merits of the various fuels for melting the charge, and the efficiency of the furnaces. Other papers were: Recent Developments in the Iron and Steel Industry of India, by C. P. Perrin; Foreign Trade, by A. H. Holliday; and Heat Treatment of Automobile Steels, by R. R. Abbott.

American Electrochemical Society

The thirty-eighth general meeting of the American Electrochemical Society was held in Cleveland on September 30 and October 1 and 2. The technical papers dealt principally with various phases of the application of electric furnaces in the steel industry. Experiments on heat losses through electrodes were reported by M. R. Wolfe and V. de Wysocki, of Lehigh University. A six-ton Heroult furnace was provided with special water-cooled rings. From records obtained by measuring the temperature of the water at intervals, the heat loss through the electrodes was estimated at 18.7 per cent of the total power supplied to the furnace. Data on the influence of copper, manganese, and chromium on the corrosion of their iron alloys, were presented by E. A. and L. T. Richardson, General Electric Co., Cleveland. Tests showed that there is a mutual action between manganese, and copper in their effect upon the atmospheric corrosion of iron. Copper alone reduces the corrosion of pure iron and to a still greater extent the corrosion of steel. This is due to the effect of manganese, which enhances the effect of copper. If manganese is replaced by chromium the effect is still more pronounced. The red-short range in iron due to the presence of copper is removed by either manganese or chromium. It is believed that there is some relation between this red-short range and resistance to atmospheric corrosion. Based upon this the film intergrain hypothesis is suggested to explain the corrosion resistance of these alloys.

A new portable standard cell was described by C. J. Rodman and Thomas Spooner. It is of the cadmium type of special design with the usual ingredients, but it has a container of hard glass with tungsten leads. Instead of the common H-type a compact concentric arrangement has been devised. Measurements of the electrical resistivity of specialized refractories were presented by M. L. Hartman, A. P. Sullivan, and D. E. Allen, research laboratory, Carborundum Co. A progress report of the Söderberg continuous electrode installation at Anniston, Ala. was submitted by Dr. Joseph W. Richards. The Söderberg electrode was introduced into the United States by Elektrokemisk Industri of Christiania, Norway. Ferromanganese is manufactured in an 1800-kw. electric furnace at the Anniston plant. Attempts to use pure nickel wire as a furnace resistor in place of nichrome wire were related by F. A. J. FitzGerald and Grant C. Mayer, FitzGerald Laboratories.

POWER TEST CODES

(Continued from page 719)

The complete statement referred to in (*b*) above should be divided as follows:

1 Object, giving authority, preliminary agreements and other relevant information.
2 Description of apparatus tested.
3 Methods of testing, giving conditions of operation, location, arrangement and method of using instruments and testing apparatus, and personnel.
4 Discussion of the data and results both as to accuracy and as bearing on the object of the test.
5 Leading conclusions.
6 Tables of data and calculated results or graphical expositions of the same.
7 Charts not included under item 6.

Reports of tests of lesser magnitude should follow the same general plan.

37 In preparing a report the work should be so done that the report will be self-contained in all respects. The best test of such a requirement is to assume that the report may be brought into court in connection with litigation involving the object for which the test was made. If the report can stand alone under such conditions it may be considered complete.

(*Signed*) William. H. Kavanaugh, *Chairman*,
Charles J. Bacon,
Geo. H. Barrus,
Arthur M. Greene, Jr.,
Clarence F. Hirshfeld.

ARMOR-PLATE AND GUN-FORGING PLANT OF U. S. NAVY

(*Continued from page 668*)

The machine-tool layout and the specifying and purchasing of the equipment was done by the machine-shop superintendent, Mr. W. E. Hayes, who is the head of the Cold Metal Department.

The general layout, industrial and structural design, design of plant services crane specifications, foundation design for all equipment, etc., were made under the author's direction in the Bureau of Yards and Docks at Washington, and details completed at South Charleston when the engineering force, with the exception of the Electrical Division, was transferred there in the Spring of 1919 to be in closer touch with the work. A Construction and Maintenance Department was organized at the Naval Ordnance Plant to build the new plant and carry on the maintenance of the Projectile Plant. It employed at maximum strength some 40 to 50 designers and draftsmen and somewhat over 1200 men in the field. The principal assistants of the writer, as head of the Construction and Maintenance Department were Mr. J. Hepinstall, supervising engineer of design; Mr. T. H. Callahan, supervising engineer of construction; Mr. W. H. Sears, materials and office, and Mr. H. M. Cogan, supervising engineer of electrical design.

Costs

Final figures of cost are not yet available. In round numbers it may be stated that the entire plant when completed will represent an investment of about $20,000,000. Construction items of the plant, including cost of all structures completely enclosed and with services, including overhead cranes but exclusive of operating equipment and equipment foundations, will total somewhat over $10,000,000.

The cost records, kept both by the intricate Navy system of accounting which imposes a more or less arbitrary overhead based on the amount of productive labor; and on a man-hour and material basis kept separately by the author, indicate that the work has been done economically. The percentage profit of a general contractor has been saved to the Department. A saving has also been made by the use of Navy cost-plus and Army salvage material and equipment.

The method adopted of handling the entire construction of the armor and gun-forging plant within the Department proved very flexible and made it possible to keep the design work and the construction work in close harmony. It also permitted essential eleventh-hour changes to be made with less inconvenience and delay than would have been possible dealing through a general contractor.

If armor ingots are cast in December, as is confidently expected, it will have taken two years and six months, in exceedingly trying times as to labor and material, to bring the plant from the "open-lot and blank-paper" stage to operation.

DISCUSSION—STEAM vs. ELECTRIC LOCOMOTIVES

(*Continued from page 688*)

to the operation of electric locomotives, and are just as much a part of the electric locomotive as the boiler is of the steam locomotive.

Extent of Electrification. Where electrification is contemplated a very serious question is: What shall be its extent? Naturally the desire would be to wipe out as many as possible of the extensive accessories to steam operation. If, however, it becomes necessary to operate steam trains over the electrified section, it will obviously be necessary to retain water stations and possibly fuel stations, provided the electrified section is sufficiently long. This operation of steam locomotives under their own power over electrified sections would be necessary in case of redistribution and possibly in case of diversions where the electrified section formed part of the diverted line. Therefore, the claim for economy in doing away with these features of steam operation would probably not be realized.

In commenting on the paper presented by Mr. Muhlfeld, Mr. Gibbs said that he believed his enthusiasm had carried him too far in minimizing the advantages of electrification. The operation of the electrified roads has undoubtedly been good whether it be terminal or road operation. He thought Mr. Muhlfeld also ignored the fact that the modern improvements which have so added to the performance of the steam locomotives are potential only. For instance, it is very possible and common by indifference to so carry water in the boiler that the superheater becomes merely a steam drier and its value disappears. In many cases, because of neglect of damper mechanism or from dirty flues, little benefit is derived from improved appliances. Modernizing of steam locomotives calls for the intelligent use of the devices, which will come when the old spirit of loyalty returns.

In summarizing his remarks Mr. Gibbs said in part: "It is to be noted that practically all of the electrifications on steam railroads so far have been based on local conditions. In the electrifications in and around cities a moving cause has been the elimination of smoke and other objectionable features incidental to steam operation, and the possibility of increasing the capacities of the passenger terminals. On the Milwaukee road it was the utilization of available water power. On the Norfolk & Western it was to secure increase in capacity on a congested mountain division with tunnel complications. It is fair to assume that other electrifications will be similarly governed by local conditions.

"If, after careful consideration of the road, based on actual train sheets for the heaviest actual or probable congested operation; the capacity and number of active and available locomotives required; crediting the operation with incidental savings which may be effected, and eliminating expenses peculiar to steam operation; it appears that there would be economy in electrification, either from actual savings or better operation, or both, it still remains for the management to decide whether the money required can be spent to better advantage for electrification than for some other features of the general operation."

Book Notes

Condensed Catalogues of Mechanical Equipment. Comprising Condensed, Uniformly Presented and Illustrated Catalogue Information Covering the Products of Manufacturers of Various Classes of Mechanical Equipment, with General Classified Directory and Consulting Engineers' Directory. Tenth annual volume. American Society of Mechanical Engineers, New York, 1920. Cloth, 6 × 9 in., 1004 pp., illus., $4.

The tenth edition of this catalog and directory of mechanical equipment and consulting engineers follows the established lines, although the data on A.S.M.E. standards have been omitted from this issue. Five hundred and nine firms are represented by condensed catalogs of their products, this section being eighty pages longer than in 1919. The directory of mechanical equipment, in which manufacturers are listed under products, is ten per cent larger, and the directory of consulting engineers covers sixty per cent more pages than before. Various improvements have also been made to facilitate convenient reference.

The Coal Trade. The Year Book of the Coal and Coke Industry. By Sydney A. Hale. 47th annual edition. The Estate of F. E. Saward, New York, 1920. Cloth, 6 × 8 in., 352 pp., tables, $4.

The present volume is, the compiler states, the largest in size and the widest in scope yet issued. It includes a variety of statistical tables of interest to those in the coal industry, brought to the latest possible dates, and information showing the development of the industry during the past year. The book contains statistics of production, exports, imports, costs, prices, ocean rates, wages and similar matter, as well as reviews of important occurrences.

Common Sense and Labour. By Samuel Crowther. Doubleday, Page & Co., Garden City, N. Y., 1920. Cloth, 5 × 8 in., 284 pp., $2.

The author discusses the causes of present-day dissatisfaction between workmen and employers, the various remedies that have been suggested, and the results obtained in actual cases. Written in readable style, and of interest to employers.

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press. At the end of the year the monthly installments are combined and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents each, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACETYLENE

See AUTOMOBILE FUELS, Acetylene.

ACCOUNTING

Taxation. The Amortization of War Facilities, Arnold F. Van Pelt. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 301–305. Suggestions as to definite procedure of value to those who have had war contracts.

AERIAL PHOTOGRAPHY

Detection of Objects. A Photographic Method of Detecting Changes in a Complicated Group of Objects, M. H. Stillman. Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 392, July 31, 1920, pp. 437–448, 9 figs. Method involves superposition of two photographs taken at different intervals. It was developed for use in military operations.

Uses. Aerial Photography (Sur la photographie aérienne), Jean-Abel Lefranc. Aérophile, vol. 28, nos. 13–14, July 1–15, 1920, pp. 204–208, 6 figs. Uses are pointed out and structural details of equipment are discussed. (To be continued.)

Aerial Photography in War and in Peace (La photographie aérienne, arme de guerre, outil de la paix), Henri Bouche. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 132, no. 4, July-Aug. 1920, pp. 464–488, 9 figs. Surveys applications of aerial photography in topographical work, and visualizes future developments.

AERONAUTICS

Federation Aeronautique Internationale. Federation Aeronautique Internationale, Harold E. Perrin. Aeronautics, vol. 19, no. 362, Sept. 23, 1920, p. 222. Notes on Conference held in Geneva on Sept. 8, 9 and 10.

[See also AVIATORS, Physiology of.]

AEROPLANE ENGINES

Diesel Type. A Twin Piston Diesel Engine Designed for Use in Aircraft. Automotive Industries, vol. 43, no. 15, Oct. 7, 1920, pp. 718–719, 5 figs. Two-stroke cycle Diesel engine developed in Germany on Oechelhauser opposed piston principle.

German Types. Development of German Aircraft Engines, Otto Schwager. Aviation, vol. 9, no. 5, Oct. 1, 1920, pp. 161–164, 9 figs. Extract from lecture given at General Meeting of Sci. Assn. for Technics of Aviation at Hamburg, April 19, 1918. (To be continued.) Translated from Technische Berichte.

Magnetos. Power Required to Drive Aeronautic Engine Magnetos and Generators. Air Service Information Circular, vol. 1, no. 42, July 30, 1920, 1 p. Power absorbed in driving Liberty generator ranged from 0.07 hp. at 1800 r.p.m. when delivering current of 1 ampere, to 0.19 hp. at 3300 r.p.m. when delivering current of 4 amperes.

Power and Altitude. Power and Fuel Consumption of Aeroplane Engines at Different Altitudes. (Prüfung der Höhenleistung von Verbrennungsmotoren in der Unterdruckkammer), H. Wilcke. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 13, July 15, 1920, pp. 185–190, 13 figs. Results of vacuum-chamber tests of power and fuel consumption of standard and supercharged engines at different densities of air and altitudes. Notes on employment of a fan in front of carburetor; overload capacity of engines; influence of temperature and exhaust back-pressure on output. Curves showing relationship between engine capacity, temperature and pressure in front of carburetor.

Turbo-Compressors for. The Problem of the Turbo-Compressor, René Devillers. Aerial Age, vol. 12, nos. 4 and 5, Oct. 4 and 11, 1920, pp. 107–108 and 139–141. Oct. 4: Tests to determine influence of back pressure at exhaust on power. Analytical determination of compression stress of air admitted to carburetor. Oct. 11: Calculations of required efficiency of turbo-compressor set. Translated from French by Paris office, Nat. Advisory Committee for Aeronautics. (To be continued.)

AEROPLANE PROPELLERS

Design. Screw Propellers, M. A. S. Riach. Aeronautics, vol. 19, nos. 360–363, Sept. 9, 16, 23 and 30, 1920, pp. 199–201, 213, 227–229, and 241–242, 4 figs. Sept. 9: "Wash" and "inflow" theories of propeller and their relation to each other. Sept. 16; Formulæ. Sept. 23: Notes on use of coefficient "K." Sept. 30: Method of designing. (Continuation of serial.)

Testing Stations. The Air Propeller Testing Station in Fischamend near Vienna (Die Luftschrauben-Prüfanstalt in Fischamend bei Wien), R. Katzmayr. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 13, July 15, 1920, pp. 192–194, 4 figs. Most important part of plant is said to be the wind tunnel with maximum length of 28 m. constructed entirely of wood and provided with four sizes of inlet nozzles ranging from 3000 to 4000 mm. diam.

AEROPLANES

Aerofoil Characteristics. The correction of Aerofoil Characteristics for Scale Effect, Alexander Thom. Flight, vol. 12, no. 40, Sept. 30, 1920, pp. 1042–1043, 4 figs. Correction curves which are constructed from results of experiments dealing with speed-scale effect.

Ansaldo Transport. New Ansaldo Transport Airplane. Aviation, vol. 9, no. 5, Oct. 1, 1920, p. 165, 1 fig. Machine is tractor biplane equipped with Fiat A 12-bis 300 hp. engine. Speed is 112 m.p.h.; weight with fuel is 2535 lb. and permissible load is 1653 lb.

British Air Ministry Competitions. Air Ministry Competitions, 1920. Eng., vol. 110, no. 2854, Sept. 10, 1920, p. 343. Table of data regarding large and small aeroplanes arranged alphabetically in each class.

Climbing Energy, Measurement of. Measurements of Energy through Climbing and Gliding Flights (Energiemessungen durch Steig- und Gleitflüge), Georg König. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 12, June 30, 1920, pp. 170–173, 8 figs. Describes measuring method developed by author and the two instruments required in connection therewith, a speed meter and a baragraph. Merits of method are demonstrated. From address before Sci. Soc. for Aviation.

Depreciation. Aircraft Depreciation. The Air Board of Canada, Bul. no. 1, May 1920, 6 pp. Also Flight, vol. 12, no. 40, Sept. 30, 1920, pp. 1039–1040 and Aeronautics, vol. 19, no. 363, Sept. 30, 1920, pp. 246–247. It is calculated that total allowance in computing cost of operations or insurance and depreciation upon new machines valued at $10,000 and used for a period of six months during which it was flown 300 hr. should be $6786, or $67^4/_5$ per cent of value of machines.

Fabrics. Fabric and Dope, with Special Reference to Deterioration of Strength and Tautness, F. W. Aston. Aerial Age, vol. 12, no. 2, Sept. 20, 1920, pp. 50–51. Experimental investigation of action of light and material ratings strength of doped and undoped linen aeroplane fabric. (To be continued.)

Fairey Amphibian. The Fairey Amphibian. Aeronautics, vol. 19, no. 362, Sept. 23, 1920, p. 223, 3 figs. Wings are fitted with variable camber flaps operated by hand-wheel at side of pilot's seat. Engine is 450 hp. Napier "Lion" fitted with hand and explosion starters.

Fighting. See CANNON, Gearing to Aeroplane Engines.

Gasoline Tanks. Covering Wing Gasoline Tanks in Martin Bomber. Air Service Information Circular, vol. 2, no. 105, Aug. 20, 1920, 3 pp. 3 figs. Illustrates method.

Helicopters. The Possibilities of the Helicopter (Die Möglichkeit des Schraubenflugzeuges), Hermann Borck. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 14, July 31, 1920, pp. 207–209, 1 fig. Writer explains conditions under which a helicopter is capable of flight, and what altitudes it can reach.

Horsepower, Variation with Altitude. The Variation of Horsepower with Altitude. Air Service, Information Circular, vol. 1, no. 92, Aug. 30, 1920, 3 pp., 1 fig. Empirical-theoretical chart for production of aeroplane performance.

Interplane Struts. Location of Interplane Struts, A. S. Niles and B. C. Boulton. Aerial Age, vol. 12, no. 3, Sept. 27, 1920, pp. 75–79 and 82, 11 figs. Experimental investigation of most economical location for struts of different types of aeroplanes, and to learn effect of different variables in changing this location. Types of aeroplanes investigated were monoplane, single-, two- and three-bay biplanes.

Messenger. Report on Wind Tunnel Test of Messenger Airplane. Air Service Information Circular, vol. 1, no. 43, July 30, 1920, 7 pp., 4 figs. Model was tested for lift, drag, and L/D, for various angles of thrust line to wind, with stabilizer settings of $+1^1/_2$ deg. and $-1^1/_2$ deg.

Performance. An Empirical-Theoretical Method of Comparative Prediction of Airplane Performance. Air Service Information Circular, vol. 1, no. 68, June 4, 1920, 9 pp., 3 figs. Chart giving variation of maximum velocity at any altitude, and absolute ceiling.

"Pioneer" Sportplane. The "Pioneer" Single-Seater Sportplane. Flight, vol. 12, no. 38, Sept. 16, 1920, pp. 998–1000, 6 figs. Characteristics: Span, 24 ft.; overall length, 14 ft. 6 in.; overall height, 6 ft. 9 in.; area of main planes, 166 sq. ft.; weight, fully loaded, 800 lb.; speed range, 25–70 m.p.h.; engine, 40 hp.; "Pioneer" 4-cylinder vertical.

Riveting of Small Tubes. Riveting of Small Tubes (Nietungen an engen Rohren), H. Theobald.

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NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ENGINEERING INDEX (Continued)

Luftfahrt, vol. 24, no. 7, July 1920, pp. 103–104, 18 figs. Also translation in Flight, vol. 12, no. 40, Sept. 30, 1920, pp. 1045–1046, 18 figs. Details of a number of tools recently manufactured by the Schütte-Lanz Airship Construction Co. in Mannheim Fheinau for inserting and securing rivets in small tubes from the inside.

Testing. Official Airplane Report Form. Air Service Information Circular, vol. 1, no. 97, Sept. 15, 1920, 7 pp., 1 fig. Blank form for reporting characteristics of machine and results obtained in tests.

VE-7 Training. The VE-7 Training Aeroplane. Aerial Age, vol. 12, no. 4, Oct. 4, 1920, pp. 110 and 114, 5 figs. Machine designed as advanced training aeroplane to be put into quantity production as standard type for U. S. Army Air Service. Dimensions: Length overall, 24 ft. 2 in.; height overall, 8 ft. 7½ in.; span, both planes, 34 ft. 3 in.; engine is Hispano-Suiza, 8-cylinder, 150-hp., water-cooled type.

Wings. Analysis of Wing Truss Stresses including the Effect of Redundancies, E. P. Warner and R. G. Miller. Nat. Advisory Committee for Aeronautics, report no. 92, 1920, 20 pp., 5 figs. It is concluded from considerations based on experiments and calculations that wooden members may be omitted from consideration in work equations without causing any serious error. Effect of stagger wires is considered unimportant when load is approximately equally distributed between form and rear trusses. It is believed that work now done by two wires could be accomplished equally well by a single one as only rarely are both wires stressed at one time.

Developments in Wing Design, Douglas Shaw. Aeronautics, vol. 19, no. 361, Sept. 16, 1920, pp. 210–211. Form of wing with single continuous high lift upper surface coupled with two tandem lower surfaces said to give longitudinal stability and to have greater efficiency than ordinary type.

The Touring Airplane and the Variable Camber Wing, J. D. Hill. Aviation, vol. 9, no. 5, Oct. 1, 1920, pp. 159–160, 1 fig. Suggests design of variable camber airplane.

Wireless Guiding of. Experiments with Wireless Guiding of Aeroplanes (Versuche über drahtlose Anpeilung von Flugzeugen), Richard Baldus and Eberhard Buchwald. Jahrbuch für drahtlose Telegraphie u. Telephonie, vol. 15, no. 3, Mar. 1920, pp. 214–236, 19 figs. Results of a number of experiments carried out by authors at the Döberitz and Lärz aviation fields during 1917 and 1918.

[See also FLIGHT; SEAPLANES.]

AIR COMPRESSORS

Turbo-Compressors. A New High-Speed Turbo Compressor, Bandroft Gore. Eng. & Min. Jl., vol. 110, no. 15, Oct. 9, 1920, pp. 717–718, 3 figs. Machines designed for Argentine copper smelter.

AIRCRAFT CONSTRUCTION MATERIALS

Dopes. General Descriptive Matter on Dopes and Instructions for the Application of Dope and Pigmented Protective Coverings. Air Service Information Circular, vol. 1, no. 44, July 30, 1920, 5 pp.

Fabrics. General Descriptive Matter on Airplane Fabrics, Tapes and Cords, and Instructions for the Application of Fabric to the Wings. Air Service Information Circular, vol. 1, no. 45, July 30, 1920, 6 pp.

New Rubberized Airship Fabrics. India Rubber World, vol. 63, no. 1, Oct. 1, 1920, p. 25. Specifications prepared by Manufacturers Aircraft Association.

On the Permeability of Thin Fabrics and Films to Hydrogen and Helium, J. C. McLennan and W. W. Shaver. Lond., Edinburgh, and Dublin Philosophical Mag. and Jl. Sci., vol. 40, no. 237, Sept. 1920, pp. 272–280. Rate of diffusion of hydrogen through series of balloon fabrics was determined experimentally. Permeability of soap films whose thickness corresponds to red-green stage was found for helium to be 670 liters per square meter per day and for hydrogen 960 liters per square meter per day at 20 deg. cent. Diffusion of hydrogen through water films filling interstices of wet cotton fabric was found to be very low; with soap films showing interference colors, rate of diffusion of both hydrogen and helium was considerable.

Plywood. Data on the Design of Plywood for Aircraft. Armin Elmendorf. Nat. Advisory Committee for Aeronautics, report no. 84, 1920, 15 pp., 6 figs. Results of investigations made by Forest Products Laboratory at Madison, Wis., for army and navy departments. Object of study was to determine, through comprehensive tests, mechanical and physical properties of plywood and how these properties vary with density, number, thickness, arrangement of plies and direction of grain of plies.

Steel Tubing. Report of Test on Steel Tubing and Wing Beams Taken from the Fokker D-VII. Air Service Information Circular, vol. 2, no. 104, Aug. 10, 1920, 4 pp., 6 figs.

AIRSHIPS

German. German Airships. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 347–348, 2 figs. Data regarding L 70 class dirigible; maximum diameter, 79 ft.; length, 745 ft.; cubic contents, 242,000 cu. ft.; useful load, 57½ tons; maximum speed, 83¾ m.p.h.; maximum weight of gasoline carried, 44 tons.

Rigid. The Effect of Distortion on the Bending Stresses in a Rigid Airship, E. H. Lewitt. Aeronautics, vol. 19, no. 360, Sept. 9, 1920, pp. 196–198, 5 figs. Derivation of formulæ, and results of experiments.

Vickers Rigid Airship R. 80. Aeronautics, vol. 19, no. 363, Sept. 30, 1920, pp. 243–245, 2 figs. Designed for use for long patrol cruises over sea and particularly to obtain greatest endurance and speed possible. Capacity is only 1,250,000 cu. ft., but airship is said to give performance in speed and endurance equal to that of R. 33 and R. 34. Dimensions: Overall length, 530 ft.; diameter, 70 ft.; height, 85 ft.; engines, four of Wolseley-Maybach type of 230 b.hp.

Schütte-Lanz. Design and Efficiency of Airships (Luftschiffe und deren Leistungsfähigkeit), D. Rühl. Ingenieur, vol. 35, no. 25, June 19, 1920, pp. 438–451 and (discussion) pp. 452–454, 23 figs. Description of Schütte-Lanz airship. Dimensions: Capacity, 2,048,360 cu. ft.; overall length, 650 ft. 8 in.; max. diam., 75 ft. 6 in.; carrying capacity, 37.5 tons. It is provided with five 240-hp. motors capable of developing speed of 62 mi. per hr. Address delivered before Department for Ship & Machine Constr. of the Roy. Inst. of Engrs., Amsterdam.

New Schutte-Lanz Construction. Aviation, vol. 9, no. 5, Oct. 1, 1920, p. 165. Airship has capacity of 2,048,360 cu. ft., overall length of 650 ft. 8 in. and maximum diameter of 75 ft. 6 in. It is provided with five 240-hp. Maybach motors which give it maximum speed of 62 m.p.h. Carrying capacity is 37.5 tons.

Semi-Rigid. The New Italian Usuelli Semi-Rigid Airship. Flight, vol. 12, no. 40, Sept. 30, 1920, pp. 1044–1045, 4 figs. Principal feature is rigid keel which consists of triangular-section girder framework extending from nose to stern, located outside envelope, apex downward, flush with bottom of latter. Principal characteristics of "Roma," as new airship is called, are overall length, 410 ft.; diameter, 82 ft. 6 in.; height, 90 ft. 3 in.; capacity, 1,200,000 cu. ft.; weight, fully loaded, 37 tons; maximum speed, 80 m.p.h.

Slow-Speed. Airships for Slow-Speed Heavy Transport and their Application to Civil Engineering, T. R. Cave-Browne-Cave. Eng., vol. 110, no. 2853, Sept. 3, 1920, 331. Possibilities of developing such airships. Paper read before Eng. Section, British Assn. for Advancement of Science.

Zeppelin. The Development of Aircraft with Special Consideration of the Zeppelin Dirigibles (Studien zur Entwicklung der Luftfahrzeuge unter besonderer Berücksichtigung der Zeppelin-Luftschiffe), P. Jaray. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, nos. 11 and 12, June 15 and June 30, 1920, pp. 153–159 and 173–178, 9 figs. From the calculated values shown in curves, conclusions regarding further development of aircraft are drawn which emphasize the marked superiority of the dirigible and establish that the giant aeroplane cannot be future popular medium of air traffic. Points out that only small aeroplane can compete with small dirigible and that no plane can compete with large dirigible. Includes tabular data of different types of Zeppelin dirigibles.

The L-72 Zeppelin at Maubeuge (Le Zeppelin "L-72" à Maubeuge). Aérophile, vol. 28, nos. 13–14, July 1–15, 1920, pp. 196–198, 7 figs. Dimensions: Length 226 meters; diameter, 26.6 meters; capacity, 68,500 cubic meters; ascensial force, 80,000 kg.

ALCOHOL

Industrial. Industrial Alcohol, Burnell R. Tunison. Jl. Franklin Inst., vol. 190, no. 3, Sept. 1920, pp. 373–420, 24 figs. Notes on manufacture of alcohol for industrial purposes. Nature and scope of alcohol industry and vast number of other industries in which industrial alcohol is a necessity are pointed out, and favorable legislation concerning industrial alcohol and stimulation of those industries which have not yet attained their proper expansion in United States.

Recovery from Coke Oven Gas. The Recovery of Industrial Alcohol from Coke Oven Gases. Gas World, vol. 73, no. 1885, Sept. 4, 1920, pp. 13–16, 1 fig. Bury and Ollander process for recovery of ethylene and its homologues from gases of distillation by use of sulphuric acid and subsequently to convert acid sulphates into industrial alcohol. Report of Fuel Economy Committee of British Assn. for Advancement of Science.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOYS

Magnesium. New Magnesium Alloy Shows Much Promise. Automotive Manufacturer, vol. 42, no. 6, Sept. 1920, pp. 33 and 35. Alloy, called Dow metal, brought out by Dow Chemical Co., Midland, Mich. It is said to contain over 90 per cent of metallic magnesium and to have specific gravity of 1.79 and tensile strength of 22,000 to 25,000 lb. per sq. in.

Metallography. Micrographic Similarities Among Carbon Steels, Brasses, Copper, Bronzes and Aluminum Bronzes (Similitudes d'aspect micrographique existant aux divers états, entre les alliages fer-carbone (aciers), cuivre-étain (bronzes d'etain), cuivre-zinc (laitons) et cuivre-aluminium (bronzes d'aluminium), A. Portevin. Comptes rendus des Seances de l'Academie des Sciences, vol. 171, no. 6, Aug. 9, 1920, pp. 350–353, 3 figs. Experimental observations. Photomicrographs.

[See also ALUMINUM ALLOYS.]

Progress during War. Improvements in Alloys and Metal Treatment (Ueber Fortschritte auf dem Gebiet der Legierungskunde und Metallverarbeitung) E. H. Schulz. Metall u. Erz, vol. 17, nos. 10 and 11, May 22 and June 8, 1920, pp. 229–233 and 251–256. Brief review of progress during war in investigation of constitution and recommendations of new alloys, production (smelting and annealing), treatment by swaging and annealing, and investigation of properties.

ALUMINUM ALLOYS

Aluminum-Copper. Foundry Methods for Light Aluminum: Copper Alloys, Robert J. Anderson. Chem. & Metallurgical Eng., vol. 23, no. 15, Oct. 13, 1920, pp. 735–737. Statement of melting and alloying practice in vogue in America for production of no. 12 alloy, and discussion of apparent advantages and disadvantages in use of copper or various copper-rich hardeners.

Manufacture of Rich Copper: Aluminum Alloys or Hardeners, Robert J. Anderson. Chem. & Metallurgical Eng., vol. 23, no. 13, Sept. 29, 1920, pp. 617–621, 5 figs. Describes methods in use in aluminum foundries of United States for manufacturing rich alloys of copper and aluminum, and details of experiments carried out for purpose of comparing different methods.

Bronzes. Self Annealing in Aluminum Bronze, Austin B. Wilson. Foundry, vol. 48, no. 19, Oct. 1, 1920, pp. 776–778, 9 figs. Results of tests of self-annealed aluminum bronze.

Hardness of. Hardness of Certain Aluminum Alloys, R. E. Search. Metal Industry (N. Y.), vol. 18, no. 9, Sept. 1920, pp. 403–405, 6 figs. Compilation of investigations of M. M. Leon Guillet, Jean Durand and Jean Galibourg, from Revue de Metallurgie. (To be concluded.)

AMMONIA COMPRESSORS

English. Some Profitable Reflections for the Intending Purchaser of Ammonia Refrigerating Plant, Leuig Chew. Cold Storage & Ice Assn., vol. 16 no. 2, 1920, pp. 35–58 and (discussion), pp. 59–68, 6 figs. on 5 supp. plates. Improvements in design and construction of ammonia compressors which are outcome of recent experimental work and comparative tests carried out by H. J. West & Co., England, and other manufacturers.

APPRAISAL

Valuation and. Appraisal and Valuation of Properties. Mech. Eng., vol. 42, no. 10, Oct. 1920, pp. 549–561 and p. 597. Symposium at St. Louis meeting of Am.Soc.Mech.Engrs. Papers given are: Rational Valuation—A Comparative Study, James Rowland Bibbins; Price Levels in Relation to Value, Cecil F. Elmes; The Cost of Organizing and Financing a Public-Utility Project, F. B. H. Paine; The Construction Period, H. C. Anderson.

APPRENTICES, TRAINING OF

French Railway Shops. Reorganization of Training of Apprentices at the Shops of the Orleans Railway (Réorganisation de l'apprentissage à la compagnie du Chemin de Fer d'Orléans), M. Chassagne. Revue générale des Chemins de Fer, vol. 39, no. 8, Aug. 1920, pp. 39–59, 8 figs. Developments during war.

Systems of Instruction. Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 53, nos. 13, 15 and 17, Sept. 23, Oct. 7 and Oct. 21, 1920, pp. 565–568, 657–659 and 765–766, 15 figs. Sept. 23: System in use in Schenectady plant of General Electric Company. Oct. 7: System in use in plant of R. Hoe & Co., New York. Oct. 21: System of instruction given to trades apprentices and machine specialists by Mergenthaler Linotype Co., Brooklyn, N. Y.

ARSENIC

Manufacture. The Manufacture of White Arsenic, E. C. Williams. Eng. and Min. Jl., vol. 110, no. 14, Oct. 2, 1920, pp. 671–673, 1 fig. Details of experimental work carried on in effort to obtain dense white product free from antimony and lead. Proper draft regulation and deep cooling chambers found essential.

AUTOMOBILE ENGINES

Burt. The New Burt Engine. Automobile Engr., vol. 11, no. 142, Sept. 1920, pp. 358–360, 10 figs. Four-cylinder, 15.9 hp., single sleeve valve power unit, fitted in new Argyll chassis.

Fuels. Utilization of Fuels in Internal-Combustion Engines (Note sur l'utilisation des combustibles dans les moteurs), André Guilleux. Technique Automobile et Aérienne, vol. 10, no. 110, 1920, pp. 82–91, 14 figs. Possibilities of utilizing other fuels than gasolene in automotive engines are discussed. Utilization of kerosene is specially studied.

Water Injection in Cylinder. The MM Auto-Injector (L'auto-injecteur MM), Nature (Paris), no. 2419, Aug. 14, 1920, pp. 51–52, 2 figs. Instrument which mixes water vapor with fuel charge entering cylinder. Fuel economy of 19 per cent is said to result from its use.

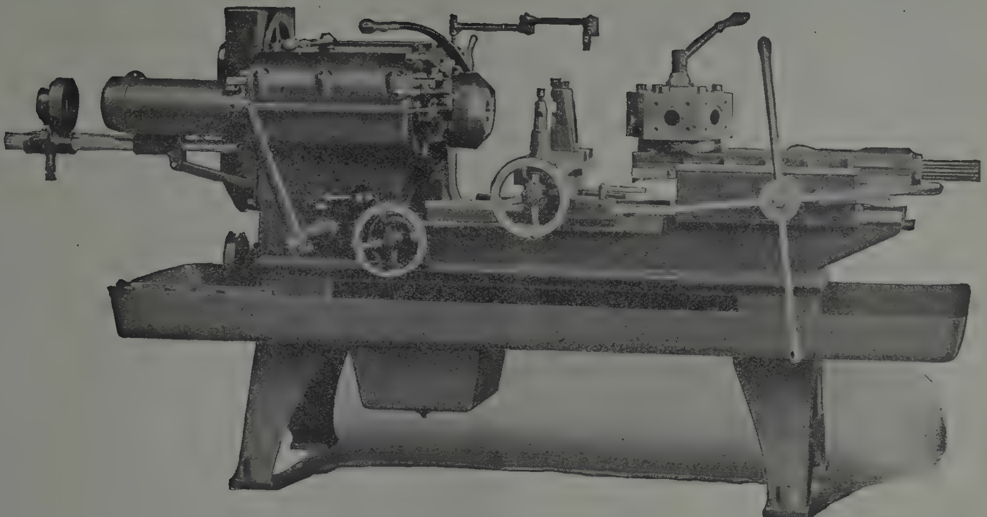
[See also CYLINDERS, Automobile Engines; CRANKCASES, Machining Operations; IGNITION.]

AUTOMOBILE FUELS

Acetylene. The Use of Acetylene as Automobile Fuel (Ueber die motorische Verbrennung des Acetylens), F. Haber. Zeitschrift für Elektrochemie, vol. 26, no. 15–16, Aug. 1, 1920, pp. 325–329. States that consumption of acetylene in place of benzine or gasoline is for German conditions an important possibility provided production of carbide is increased by a greater production of coal. Address before German Bunsen. Soc.

Alcohol. Alcohol Fuel Patents. Motor Traction, vol. 31, no. 813, Sept. 27, 1920, pp. 310–311, 3 figs. Legal considerations affecting their validity.

Alcohol-Benzol Mixtures. Alcohol-Benzol Fuels are Found Satisfactory Abroad. Power Wagon, no. 191, Oct. 1920, p. 22. Higher efficiency and



No. 6 Geared Head Turret Lathe

The New Nos. 4 and 6 Geared Head Turret Lathes

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- Yamatake & Company, Tokyo.
- McLeod & Company, Calcutta.
- Anderson, Meyer & Company, Ltd., Shanghai.
- Brossard-Mopin & Company, Saigon, Singapore, Haiphong.

ENGINEERING INDEX (Continued)

easier starting is claimed for such fuels by London General Omnibus Co. who have experimented with them under service conditions. Mixtures used have been 50 per cent alcohol and benzol.

Hydroaromatic. Possible Sources of Home-Produced Motor Spirit, E. de Barry Barnett. Chem. Age (Lond.), vol. 3, no. 64, Sept. 4, 1920, pp. 254–255. Suggests hydrogenation of aromatic bodies so as to yield hydroaromatic fuels of low density.

[See also GASOLINE.]

AUTOMOBILES

Air Propeller-Operated. The Air-Propeller Automobile (Das Luftschrauben-Automobil). Allgemeine Automobil-Zeitung, vol. 21, no. 33, Aug. 14, 1920, p. 23, 1 fig. Discussion of its advantages and disadvantages.

Aluminum Parts. Machining Aluminum Automobile Parts. Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 115–119, 9 figs. Machining operations performed in construction of Essex car built by Hudson Motor Car Co., Detroit, Mich.

Clutches, Machining. Machining Clutch Parts on Turret Lathes. Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 156–159, 11 figs. Tooling equipment used in plant of Borg & Beck Co., Chicago, Ill., for machining automobile clutches.

Gears, Change-Speed. Basic Principles Governing the Construction of Change-Speed Gears for Motor Cars and Description of a New Gear (Grundsätze über den Bau von Wechselgetrieben für Motorwagen und Beschreibung eines neuen Getriebes), H. v. Soden. Motorwagen, vol. 23, nos. 20 and 21, July 20 and 31, 1920, pp. 357–360 and 377–380, 8 figs. States that the dissimilarities in change-speed gear constructions are not based on necessity, and that it is possible to employ a unit construction for all cases in motor car work provided it is carried out in different sizes. Gives description of a gear developed according to described principles.

Italian Types. The 35.8 H. P. 8-Cylindered Isotta-Fraschini. Auto, vol. 25, no. 38, Sept. 16, 1920, pp. 962–965, 10 figs. Italian type. (To be continued.)

Specifications. British Standard Dimensions for Body Spaces and Frame Ends for Chassis for Private Automobiles. British Eng. Standards Assn., no. 100, 1920, 8 pp., 4 figs. Specifications approved in March 1920.

Wheels. Indestructible Pressed Steel Double Disc Wheels. Automotive Manufacturer, vol. 42, no. 6, Sept. 1920, pp. 30–31, 1 fig. Built on triangle principle and equipped with Firestone demountable rim.

[See also GARAGES; TIRES, RUBBER.]

AVIATORS

Physiology of. Physiological Effects of Insufficient Oxygen Supply, J. Barcroft. Nature (Lond.), vol. 106, no. 2656, Sept. 23, 1920, pp. 125–129. From presidential address delivered at Physiology Section, British Assn. for Advancement of Science.

B

BALLOON FABRICS

Fireproofing. The Fireproofing of Sacking, Tent Linen and Balloon Material (Die Imprägnierung von Sackstoffen, Zeltleinen und Ballonstoffen gegen Feuer), W. Hacker. Feuerwehrtechnische Zeitschrift, vol. 8, no. 13–14, July 5–20, 1920, pp. 109–112. Of all the media for rendering textiles fireproof, ammonia sulphate and ammonium phosphate are said to be the most expedient. Description of various foreign and domestic patents.

BARGES

Resistance to Traction. Removable Bow for Diminishing Resistance of Barges to Traction (Avant-bec mobile pour diminuer la résistance des péniches à la traction), M. Vidal. Annales des Ponts et Chaussées, vol. 66, no. 3, May-June 1920, pp. 285–296, 3 figs. Design used in barges operated in Seine river. Results of experiments in which resistance of barge, with and without bow, was measured.

BEAMS

Calculation of Size. Short Cut to Accurate Calculations, E. I. Freese. Am. Architect, vol. 118, no. 2336, Sept. 29, 1920, pp. 416–418, 2 figs. Tables for calculating sizes of timber beams and steel girders.

Continuous. Calculation of Continuous Beams Supported on Elastic Pillars (Calcul des poutres continues sur piliers élastiques), J.-P.-L. Busset-Schiller. Bulletin technique de la Suisse romande, vol. 46, nos. 17, 18 and 19. Aug. 21, Sept. 4 and 18, 1920, pp. 196–199, 210–212, and 220–221, 12 figs. Aug. 21: Derivation of formulæ for computing stresses; Sept. 4: Numerical applications of formulæ; and Sept. 18: Effect of temporary increase.

Reinforced-Concrete. Control Cement Content by Field Beam Tests, Marshall G. Findley. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, pp. 703–704, 2 figs. Machine devised on New Orleans inner harbor canal, which measures breaking load of large concrete beams.

BEARING METALS

Substitutes. Substitute Bearing Metals (Ersatz-Lagermetalle), Karl Radunz. Metall-Technik, vol. 46, no. 21–22, May 31, 1920, p. 83. Results of tests carried out in laboratory of Aircraft Arsenal in Vienna, described in Motorwagen (no. 3, Jan. 31, 1920), show that for aerial engines soft alloys can also be used, the more so because they do not weaken the crankshaft pins and improve lubrication of bearings.

BEARINGS

Expanding of. Expanding Bronze Bearings, C. M. Cross. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 452–453, 1 fig. Method for expanding loose armature bearings of electric motors.

Self-Lubricating Bushings. New Bearing Material Announced after 6 Years' Tests, Charles H. Fish. Belting & Transmission, vol. 17, no. 7, Oct. 5, 1920, pp. 37–38. Description of cellugraph, a self-lubricant bushing made of hard wood impregnated by long and carefully followed chemical treatment, which is said to form basis of practically inexhaustible supply of lubricant.

BEARINGS, BALL

Load-Carrying Capacity. Load-Carrying Capacity of the Single-Row Groove-Type Ball Bearing, Arvid Palmgren. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 335–339, 9 figs. Methods of investigating, both theoretically and experimentally, carrying capacity of ball bearings, followed by SKF Co., Gothenburg, Sweden.

Standard Allowances. Ball Bearing Allowances (Kugellagerpassungen), Friedrich Weidmann. Betrieb, vol. 2, no. 13, July 1920, pp. 325–330, 4 figs. Critical discussion of the allowances heretofore employed for ball bearings and recommendations for the development of a unit system, taking into consideration the work of the German Industry Committee on Standards (NDI).

Ball Bearing Allowances (Passungen für Kugellager), H. Gohlke. Betrieb, vol. 2, no. 13, July 1920, pp. 330–331, 3 figs. States that special allowances are necessary for ball bearings and gives recommendations for the development of a system for allowances.

BELTS

Built-up Leather. Built-up Leather Belts and their Employment (Lederhochkantriemen und ihre Verwendung), H. Türck. Braunkohle, vol. 19, no. 14, July 17, 1920, pp. 179–182, 5 figs. Describes belts built up from narrow strips placed edgewise and riveted together. Points out their advantages among which is their adaptability for main drives and heavily loaded drives, and the possibility of transmitting large amounts of power with relatively narrow belts.

BLAST-FURNACE GAS

Analysis. Blast-Furnace Gas Analysis and the Phenomena in Blast Furnaces (Gichtgasanalyse und die Vorgänge im Hochofen), H. Jüptner. Berg- u. Hüttenmännisches Jahrbuch, vol. 68, no. 1, 1920, pp. 1–48, 3 figs. Writer seeks to draw conclusions regarding these phenomena from the composition of blast-furnace gas, basing his calculations on the volume-percentage composition rather than on the weights of the constituents of gas, as heretofore commonly done.

Cleaning. New Multi-Centrifugal Gas Cleaner, A. R. Schulze. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct. 1920, pp. 553 and 574, 1 fig. New development used at Mingo and Bellaire works of Carnegie Steel Co. which does away with losses caused by wet washing blast-furnace gas.

Rough-Cleaning of Blast-Furnace Gas at Skinningrove by the Lodge Electrostatic Process, A. Hutchinson and E. Bury. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 9, 18 pp., 4 figs. It is said that with 80 to 85 per cent of electrostatic plant at work, remainder awaiting electrical equipment dust in gas has been reduced from 5 to 6 gr. per cu.m. in dirty gas to 0.8 to 1.1 gr. in cleaned gas, and that above results have been attained with total fuel consumption corresponding with 50 kw. only. It is added that no power is necessary for pumping water or for moving gas through system and recovery is effected of 48 to 50 tons per week containing 27 per cent KCl.

Use as Fertilizer. Blast-Furnace Gas as Agricultural Fertilizer (Emploi des gas de hauts fourneaux pour la fertilisation carbonique en agriculture), F. Riedel. Chaleur & Industrie, no. 3, May 1920, pp. 178–181, 2 figs. Blast-furnace gas enriches air with carbonic acid and this favors growth of plants. Experiments showed that such fertilization gives results 2 to 2.3 times better than under ordinary conditions. Translated from Stahl und Eisen.

BLAST FURNACES

Heat Supply. Variations in the Heat Supplied to the Blast-Furnace, and their Effect on the Fuel Consumption, W. W. Hollings. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 6, 12 pp. It is concluded from analytical premises set forth in paper that for countries with such low average absolute moisture as England it does not pay to install dry-blast, and that crushing of materials of charge to uniform size may be expected to result in considerable economy of fuel required per ton of pig iron.

New Jersey. New Blast Furnaces of Replogle Steel Co. Iron Age, vol. 106, no. 15, Oct. 7, 1920, pp. 895–901, 11 figs. Two furnaces recently added are 90 ft. high with diameter of 21 ft. 6 in. at bosh, 17 ft. 6 in. in crucible and 16 ft. 10 in. at stock line. They are rated at 500 tons per day each.

Remodeling. Remodeled Blast Furnace. Iron Age, vol. 106, no. 17, Oct. 21, 1920, pp. 1064–1065, 1 fig. How capacity of blast furnace was increased two-thirds.

Safety in Operation. Safe Practices in Blast Furnace Operations, L. A. Touzalin. Iron Age, vol. 106, no. 16, Oct. 14, 1920, pp. 971–972. Gas most serious hazard. Need of care in use of helmets. Hot-metal and cinder burns. Skip hoist cause of accidents. From address delivered before Nat. Safety Council.

Smelting Costs and Values. Calculation of Unit Smelting Costs and Values, C. A. Grabill. Eng. and Min. Jl., vol. 110, no. 13, Sept. 25, 1920, pp. 615–620. Calculation of blast-furnace charges and costs, fixed vs. operating expenses and their effect.

BLIND

Employment. Blind Workers Prove Efficient, Eva B. Palmer. Can. Machy., vol. 24, no. 14, Sept. 30, 1920, pp. 297–299, 4 figs. It is said that 69 operations are successfully accomplished by blind workers employed at Cleveland shops.

BOILER FIRING

See PULVERIZED COAL, Boiler Firing.

BOILER PLANTS

Studebaker, South Bend, Ind. New Studebaker Boiler Plant at South Bend. Power, vol. 52, no. 15, Oct. 12, 1920, pp. 568–572, 6 figs. Fifteen-million-dollar unit with initial capacity of 4160 hp., and well equipped with labor-saving devices and instruments to indicate operation.

BOILERS

Electrically Heated. Electric Heating (Note relative au chauffage électrique), R. de la Brosse. Revue générale de l'Électricité, vol. 8, no. 11, Sept. 11, 1920, pp. 344–345. Efficiency of electric heating for industrial purposes is studied from experiences in Switzerland where electricity is being used for heating boilers.

Making Steam Electrically in Switzerland, E. J. Constam-Gull. Power, vol. 52, no. 15, Oct. 12, 1920, pp. 596–598, 5 figs. Performance data on electrically fired steam boilers in Switzerland. Description of boilers.

Recent Applications of the Revel Electric Boiler in Swiss Industries (Neuere Anwendungen der elektrischen Revel-Kessel in der Schweizerischen Industrie), E. G. Constam-Gull. Schweizerische Bauzeitung, vol. 76, nos. 4 and 5, July 24 and 31, 1920, pp. 42–44 and 54–55, 9 figs. Results of experiments with a Revel boiler carried out at the instigation of the Swiss Assn. of Steam Boiler Masters.

Revel Electric Boiler (La production de la vapeur par l'électricité. Chaudière à chauffage électrique, système Revel), E. G. Constam-Gull. Génie Civil, vol. 77, no. 10, Sept. 4, 1920, pp. 193–195, 3 figs. Heating is effected by passage of alternating current through the water. A boiler 2.5 meters high and 0.6 meter in diameter, fed with current at 500 volts, gives per hour 550 kg. of steam at 15 kg. per sq. cm. Translated from Schweizerische Bauzeitung.

Heat-Balance Calculations. Calculation of Heat Balance by Means of Oxygen and Nitrogen Contents of Fuel (Influence de l'oxygene et de l'azote contenus dans un combustible sur le calcul rapide du bilan thermique), P. de Groote. Chaleur & Industrie, no. 3, May 1920, pp. 184–188, 2 figs. Ternary diagrams showing compositions of principal fuels of the world, that is, coals, lignite, peat, etc.

Tubes. Segregation in Bars for Steel Tubing, Harold D. Newell. Chem. & Metallurgical Eng., vol. 23, no. 15, Oct. 13, 1920, pp. 745–746, 4 figs. Results of examination for segregation in acid and basic steel ingots for boiler-tube steel with and without additions of aluminum in ladle. It is concluded that when no aluminum is added, excessive segregation usually occurs down central part of ingot anywhere from 6 in. from top to half-way down entire ingot, sulphur tending to segregate the most, then phosphorus, carbon and finally manganese.

[See also CORROSION, Boilers; FURNACES, BOILER; LOCOMOTIVE BOILERS.]

BOILERS, WATER-TUBE

Houghton's Patent. Houghton's Patent Water-Tube Boilers. Steamship, vol. 32, no. 376, Oct. 1920, pp. 87–88, 6 figs. Invention relates to water-tube boilers of type in which down-comer and up-comer tubes communicate with common water vessel. Water drum is fitted with guide tube arranged eccentrically therein so that water from down-comer tubes passes under or round said guide tube before reaching up-comer tubes, thereby ensuring uninterrupted flow in direction required.

Renewal of Parts. The Renewal of Tubes. Headers and Baffles in Water Tube Boilers (Das Auswechseln der Röhren, Kammern und Lenkwände bei Wasserrohrkesseln), Feuerungstechnik, vol. 8, no. 22, Aug. 15, 1920, pp. 181–184, 12 figs. Description of methods and tools employed.

BRASS

Bar Stock, Weight of. See STEEL, Bar Stock.

Cobalt. Cobalt Brasses (Les laitons au cobalt), Léon Guillet. Revue de Métallurgie, vol. 17, no. 7, July 1920, pp. 494–500, 13 figs. Macrographic and micrographic analyses, and study of mechanical properties of alloys with different cobalt contents.

Electrodeposition of. The Electrodeposition of Brass from Cyanide Solutions, Alfred L. Ferguson and Earl G. Sturdevant. Gen. Meeting Am. Electrochem. Soc., Sept. 30–Oct. 2, 1920, paper no. 12, pp. 87–122, 7 figs. It is established as result of experimental work that increase in ratio of copper to zinc in solution increases percentage of copper in deposit, that solutions of high metal content are

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ENGINEERING INDEX (Continued)

more satisfactory than dilute solutions, and that increase in temperature decreases cathode polarization and consequently increases percentage of copper in deposit.

Gases, Influence of. The Influence of Gases on High-Grade Brass, T. G. Bamford and W. E. Ballard. Eng., vol. 110, no. 2855, Sept. 17, 1920, pp. 390–394, 6 figs. Experimental. It is concluded that in ordinary foundry practice, using coke-fired natural draught wind furnace, it is impossible to impair seriously mechanical properties of casting by overheating. It is said that cooling metal to within 40 deg. cent. of liquidus will certainly ruin mechanical properties of high-grade brass which has been melted in ordinary furnace atmospheres and will probably render casting porous. A minimum temperature of 1150 deg. cent. is recommended for casting tubes 50 : 29 : 1. (Abstract.) Paper read before Inst. of Metals.

Nickel. New Researches on Nickel Brass (Nouvelles recherches sur les laitons au nickel), Léon Guillet. Revue de Métallurgie, vol. 17, no. 7, July 1920, pp. 484–493, 17 figs. Macrographic and micrographic analyses, and determination of variation of strength and resilience with nickel content.

BRASS FOUNDING

English Practice. Notes on Brass Foundry Practice at Messrs. Vickers, Ltd., Barrow-in-Furness, H. B. Weeks. Eng., vol. 110, no. 2855, Sept. 17, 1920, pp. 389–390. Paper read before Inst. of Metals.

BUILDING CONSTRUCTION

Clay-Core Walls. Clay Construction (Der Lehmbau), K. Dümmler. Ziegelwelt, vol. 51, no. 27, July 10, 1920, pp. 301–304, 9 figs. Writer suggests use of bricks as facing for clay-core walls, and recommends use of quarter bricks therefor.

Costs. Curves of Building Cost Increases Used in Valuation Work, F. E. Barnes. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, pp. 702–703, 2 figs. Based on data compiled by valuation engineer of New York Central lines. Frame and brick structures are considered.

New York City. Ten Years' Building and Housing Activity in New York. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 598–599, 1 fig. Statistics.

C

CABLES, ELECTRIC

Unipolar. Unipolar Cables with Lead Covering Càbles unipolaires sous enveloppe de plomb), P. Capdeville. Revue génerale de l'Électricité, vol. 8, no. 11, Sept. 11, 1920, pp. 339–344, 14 figs. Application of theory worked out in Revue générale de l'Électricité, Aug. 7, 1919, p. 177 to three-phase line to transport 30,000 kw.

CANAL BOATS

See RIVER VESSELS, Coal Barges.

CANNON

Gearing to Aeroplane Engines. Report of Test of 37-mm. Automatic Cannon in Cannon Engine. Air Service Information Circular, vol. 1, no. 32, May 5, 1920, 6 pp., 6 figs. At slow speeds of operation of engine, cannon-hopper casting vibrates sufficiently to seriously affect fire. At normal operating speed of engine vibration continues and prevents proper rate of automatic fire of cannon. Firing of cannon has no apparent effect on operation of engine.

CARBON BLACK

Manufacture. The Channel Process of Making Carbon Black, Roy O. Neal. Chem. & Metallurgical Eng., vol. 23, no. 15, Oct. 13, 1920, pp. 729–734, 12 figs. Details of plant construction.

CARBURETORS

Alba. The Alba Carburetor (Der Alba-Vergaser), Wa. Ostwald. Allgemeine Automobil-Zeitung, vol. 21, no. 33, Aug. 14, 1920, pp. 28–29, 3 figs. Construction details and various interesting features of new carburetor, the lower parts of which revolve freely about its vertical axis and the throttle lever can be locked on both sides in all directions.

CARBURIZATION

Copper Plating and Depth of. The Effect of Depth of Copper Plating on Carburization, F. P. Zimmerli. Mech. Eng., vol. 42, no. 10, Oct. 1920, pp. 565–566 and p. 602, 6 figs. Experimental determination of least amount of copper which must be plated on piece of steel in order that within specified time no carbon shall have penetrated through coating and gone into steel. It was found that the depth of copper plating for ordinary work need not be over 0.0002 in., or with 100 per cent safety factor, 0.0004 in., and it is believed that very often lesser thickness would be sufficient.

CARS

Automatic Pipe Connector. The Beahm Automatic Train Pipe Connector. Ry. Mech. Engr., vol. 94, no. 9, Sept. 1920, pp. 585–586, 5 figs. Principal features are pin and funnel aligning device and provision for coupling to air and steam hose.

CARS, FREIGHT

Draft-Gear Tests. Draft-Gear Tests, U.S.R.A. Ry. Rev., vol. 67, no. 14, Oct. 2, 1920, pp. 506–510, 4 figs. Charts of impact tests made at plant of Symington Co. at Rochester, N. Y. (Continuation of serial.)

CARS, TANK

Unloading. Rules for Unloading Tank Cars of Inflammable Liquids. Oildom, vol. 11, no. 10, Oct. 1920, p. 13. Instruction for unloading tank cars of inflammable liquids, embodying modifications suggested by petroleum industry in response to American Petroleum Inst.'s circulars containing tentative draft.

CASE-HARDENING

See CARBURIZATION.

CAST IRON

Electric-Furnace Refining. Electric Furnaces and the Sulphur Problem in Cast Iron, George K. Elliott. Iron Age, vol. 106, no. 15, Oct. 7, 1920, pp. 919–920. It is held that electric refining means better castings and less manganese consumption. Very low sulphur is not considered necessary. Paper read before Am. Foundrymen's Assn.

Research on. Future Research on Cast Iron. J. H. Andrews. Eng. and Indus. Management, vol. 4, no. 13, Sept. 23, 1920, p. 397. Points out field of research, such as determination of dilatation curves, electrical resistivity determinations and investigations on cupola slags. From paper read before Annual Conference of Instn. of British Foundrymen.

Zirconium in, Effect of. Effect of Zirconium in Cast Iron, Richard Moldenke. Iron Age, vol. 106, no. 16, Oct. 14, 1920, pp. 968–969. Tests on alloys containing up to 30.6 per cent zirconium. It was noticed that for smaller percentages metal behaved nicely in melting and indicated purifying action, for slags came up and collected for easy removal. Larger percentages gave more trouble and chilled metal considerably so that it was difficult to pour successfully. Paper read before Am. Foundrymen's Assn.

CASTINGS

Non-ferrous. Heat Control in Non-ferrous Melting, John Arnot. Foundry, vol. 48, no. 19, Oct. 1, 1920, pp. 766–767. Influence exerted by temperature at pouring in quality of non-ferrous castings. British methods of measuring temperature are outlined and instruments described. Paper read before Instn. British Foundrymen.

CEMENT GUN

Fire-Resistant Properties. "Gunite" is Proven Highly Fire Resistant, B. C. Collier. Contract Rec., vol. 34, no. 39, Sept. 29, 1920, pp. 932–934, 3 figs. Underwriters' tests are said to have indicated that cement gun could be classed as superior fire retardant.

CEMENT, PORTLAND

Specifications. British Standard Specification for Portland Cement. British Eng. Standards Assn., no. 12, 1920, 18 pp., 6 figs. Specifications approved on Aug. 5, 1920.

Tests. On Long-Time Tests of Portland Cement, Hydraulic Lime, and Volcanic Ashes, I. Hiroi. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 7, June 30, 1920, pp. 155–172, 32 figs. on 10 supp. plates. Tests included study of influence of surrounding bodies on strengths of cement and hydraulic lime, influence of qualities of sands used in mortars, strengths of mortars of various proportions in sea-water, effect of curing on strength of mortars, behavior of volcanic ashes as ingredients in cement mortars, effect of ramming on strength of mortars, effect of variation in quantity of water used in mortars, effects of storage and aeration on setting-time and strength of cement, strengths of mortars of various proportions in air, fresh-water, and sea-water, effect of mixing common salt in mortars.

CHEMICAL INDUSTRY

Developments. Recent developments in Chemical Plant and Machinery, W. B. Davidson. Chem. Trade Jl. & Chem. Engr., vol. 67, no. 1741, Oct. 2, 1920, pp. 435–438. Developments in England in manufacture of sulphuric acid, developments in German chemical plant, and survey of patents and inventions.

New York Exposition. Sidelights on the Chemical Exposition. Chem. and Metallurgical Eng., vol. 23, no. 14, Oct. 6, 1920, pp. 653–657, 4 figs. Notes on new developments as featured at Sixth National Exposition held in New York, September 20 to 25.

CHRONOMETERS

Regulating Mechanism. Regulating Mechanism of Chronometers (Sur les organes réglants des chronomètres), Jules Andrade. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 9, Aug. 30, 1920, pp. 458–461. Proposed simplification of present system employing spiral springs.

CENTRAL STATIONS

Coal Storage. Effect of Coal Situation. Elec. World, vol. 76, no. 16, Oct. 16, 1920, pp. 772–775. Reports from 54 central stations show storage one-third normal. Prices average 176 per cent higher, economy and boiler rating are much impaired and operating difficulties are greatly increased.

Financing. Central-Station Financing, H. M. Addinsell. Elec. World, vol. 76, no. 15, Oct. 9, 1920, pp. 725–727. Proper ratio of debt to capitalization and of earnings to interest. From paper read before Assn. of Edison Illuminating Companies.

France. Description of and Operating Experiences in a Large French Central Station (Ein französisches Grosskraftwerk, Beschreibung, Betriebserfahrungen), E. Cramer. Elektrotechnische Zeitschrift, vol. 41, no. 27, July 8, 1920, pp. 528–430, 8 figs. Describes the Valenciennes central station plant as an example of French-Belgian technique in the construction of electrical works. Points out defects along with advantages of plant.

Improvements. Present-Day Desiderata in the Construction of Central Stations (Neuere Gesichtspunkte für den Bau von Grosskraftwerken), G. Klingenberg. Elektrotechnische Zeitschrift, vol. 41, nos. 29, 30, 31, 32 and 33, July 22, 29, Aug. 5, 12 and 19, 1920, pp. 561–564, 586–590, 609–612, 630–633 and 650–654, 50 figs. Notes on thermotechnical improvements of power stations, improvement of heat balance, feedwater preheating, combustion preheating; increased mechanical operation of plants; reduction of cost of installation—cast- and wrought-iron feedwater heaters, arrangement of live steam piping, smokestacks and flues; coupling of the plants, size of the reserves; utilization of by-products, modern gas producers and gas turbines; protection against excess voltages and excess currents; reactance coils, generator protection, connections between generators and switch gear; development of porcelain insulators, etc.; ring networks; etc.

COAL

Distillation of. Extraction of Different Products from Distillation of Coal. Process and installations of the Société du Gaz de Paris (L'extraction des différents produits de la distillation de la houille. Procédés et installations de la Société du Gaz de Paris), A Grebel. Génie Civil, vol. 77, no. 9, Aug. 28, 1920, pp. 165–170, 13 figs. Recuperation of naphthalene and benzol.

Economic Selection of. Economic Selection of Coal, A. L. Booth. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 1a, 9 pp., 16 figs. on supp. plate. Photomicrographic studies of coal and conclusions as to their suitability for various kinds of work. Only coals in commercial use in England are considered. It is determined, for example, that Humic coals, which contain fair proportion of cuticle or spores, are most suitable for steam raising.

Storage. Bituminous Coal Storage Practice, H. H. Stoek, C. W. Hippard, W. D. Langrty. University of Illinois Bul., Eng. Experiment Station, Bul. no. 116, 157 pp., 75 figs. Data obtained from replies received from questionnaire sent to representative individuals and companies, from investigations made by writers of fires in coal piles which have occurred in various parts of the country, and from information furnished by Fuel Conservation Section of U. S. Railroad Administration.

Western Types. Temperatures at which Ash from Western Coals Fuses to a Sphere, W. A. Selvig, L. R. Lenhart and A. C. Fieldner. Coal Age, vol. 18, no. 14, Sept. 30, 1920, pp. 677–682, 5 figs. Tables giving results obtained for western coals including those from Alaska, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington and Wyoming.

COAL GAS

Adding Water Gas to. Advantages and disadvantages of Adding Water Gas to Illuminating Gas (Avantages et inconvénients de l'adjonction du gas à l'eau au gaz d'éclairage), H. Pfeiffer. Journal des Usines à Gaz, vol. 44, nos. 16 and 17, Aug. 20 and Sept. 5, 1920, pp. 253–255 and 266–271. Conference delivered before Union of Gas and Water Technicians of Saxony and Thuringia. From Journal für Gasbeleuchtung.

COAL MINES

Electrification of. The Electrification of the Works and Collieries of the Ebbw Vale Steel, Iron and Coal Company, Limited, Walter Dixon. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 3, 11 pp., 5 figs. Principal Power Station is equipped with four turbo alternators, two of 2000 kw. and two of 5000 kw. Alternating current is generated at 2000 to 2200 volts, three-phase, with periodicity of 50, and turbines are arranged for steam pressure of 175 lb. with superheat.

Firedamp. Effects of Earth Pressure in Coal Mining (Quelques effects de pressions de terrains dans les exploitations houillères), L. Morin. Bulletin et comptes rendus mensuels de la Societé de l'Industrie minérale, vol. 17, no. 3, May-June 1920, pp. 229–274, 2 figs. Sudden disengagements of firedamp are explained as resulting from mechanical actions on coal produced by great pressures it has borne in terrestrial movements, as also from pressures to which it might have been subjected in recent times. It is, therefore, concluded that study of instantaneous vibrations of firedamp should be linked with examination of pressures that have existed in region. Points to consider in coal mining for preventing sudden escape of firedamp are also formulated.

[See also MINE-RESCUE WORK.]

COAL MINING

Culm. Removing Boiler Ash, Burned Coal and Slate from the Coal in a Culm Bank, Dever C. Ashmead. Coal Age, vol. 18, no. 16, Oct. 14, 1920, pp. 796–798, 3 figs. Problems involved in preparation of anthracite from culm banks.

Stripping. A Modern Coal Stripping Installation. Excavating Engr., vol. 14, no. 8, Oct. 1920, pp. 259–261, 2 figs. Description of allied Coal Co.'s installation in Ohio with special reference to operation of coal-stripping and coal-loading shovels.

[See also EXPLOSIVES, Safety Devices.]

COAL POCKETS

Design. Coal Pockets—A Construction Opportunity, W. G. Kaiser. Concrete, vol. 17, no. 4, Oct. 1920, pp. 120–122, 5 figs. Coal pockets equipped with power-driven conveyors for unloading coal from cars into bins and with gravity chutes

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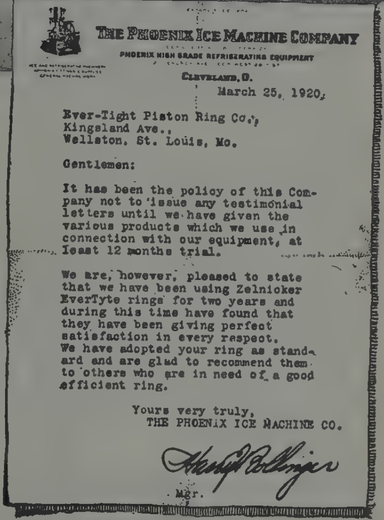

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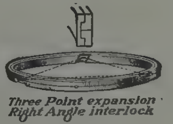

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ENGINEERING INDEX (Continued)

for transferring it from bins to wagons or trucks for delivery.

COAL STORAGE

Fires. Typical Fires in Stored Coal, W. D. Langtry. Power, vol. 52, no. 14, Oct. 5, 1920, pp. 546–547, 10 figs. From records of fires compiled by U. S. Fuel Administration for Illinois.

COLUMNS

Concrete. Spirally Reinforced Concrete Columns with Stone Cores (Umschnürte Betonsäulen mit Steinkernen), Fritz Emperger. Schweizerische Bauzeitung, vol. 76, no. 5, July 31, 1920, pp. 49–51, 6 figs. Recommends use of artificial or natural stone of high compressive strength for increasing usefulness of narrow compressional members, such as columns and arch bridges. (To be concluded.)

COMBUSTION

Air Preheaters. Recuperation of Heat in Products of Combustion with Air Preheaters (Sur la récupération de chaleur sensible dans les produits de la combustion par l'emploi de l'air chaud), G. Bastien. Chaleur et Industrie, no. 5, July-Aug. 1920, pp. 297–301. Results of tests showing economical value of air preheaters.

Propagation of. Propagation of Combustion (Les régimes réguliers de propagation des combustions), L. Crussard. Technique Moderne, vol. 12, no. 6, June 1920, pp. 243–250. Combustion is divided into two general classes, detonation and deflagration. Method of propagation is studied theoretically in each case.

CONCRETE

Aggregates, Proportioning. Surface Area of Sand Determined by Volume-Moisture Relations, R. B. Young and W. D. Walcott. Eng. World, vol. 17, no. 4, Oct. 1920, pp. 243–245, 5 figs. Results of tests carried out in laboratories of Hydro-Electric Power Commission of Ontario as part of extended research being conducted there into problem of concrete proportioning.

Aggregates, Testing. Making sure of the Concrete Batch. Sci. Am. vol. 123, no 15, Oct. 9, 1920, p. 379, 1 fig. Apparatus for testing aggregates, develped at United States Bur. of Public Roads.

Alkali Soils, Action of. Concrete in Alkali Soils and Waters, A. S. Dawson. Jl. Eng. Inst. of Canada, vol. 3, no. 10, Oct. 1920, pp. 476–493. Experimental work by Concrete Committee of Eng. Inst. of Canada. It has so far been found that in concrete of high density, where absorption of alkali ground water is mainly at surface of concrete, action is relatively slow and is largely in the nature of surface action, gradually extending to interior; presence of alkali soil solutions does not retard setting of cement; action is more rapid in weaker mixtures and mixtures of low density.

Research. Notes on Recent Developments in Concrete, H. C. Boyden. Jl. Am. Water Works Assn., vol. 7, no. 5, Sept. 1920, pp. 672–682. Research work conducted at Structural Materials Research Laboratory at Lewis Institute, Chicago.

CONCRETE BLOCKS

Brick vs. Comparative Cost of Laying Block and Brick, A. J. R. Curtis. Concrete, vol. 17, no. 4, Oct. 1920, p. 130, 1 fig. Figures obtained in actual cases show greater economy of concrete block.

CONCRETE CONSTRUCTION

Portable Track and Cars for. Use of Portable Track and Cars in Concrete Construction, William Wren Hay. Concrete, vol. 17, no. 4, Oct. 1920, pp. 128–130, 1 fig. Table giving costs of loading and unloading materials.

CONCRETE CONSTRUCTION, REINFORCED

Office Buildings. Reinforced Concrete Office Buildings for New York City. Eng. World, vol. 17, no 4, Oct. 1920, pp. 233–235, 1 fig. Proportions for concrete used in building under construction for Western Electric Co. are generally 1 : 2 : 4 but in certain columns richer mixture is used. Specifications require use of $1^{1}/_{2}$ in. stone.

CONCRETE, REINFORCED

Flat-Slab. Concrete Flat Slab Regulations. Eng. World, vol. 17, no. 4, Oct. 1920, pp. 239–240. Adopted by New York City as standard.

Roof Trusses. Concrete Trusses and Cantilever Girders in Theatre. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 604–605, 4 figs. Roof cost reduced by substituting concrete for steel. Balcony has heavy girders and long cantilevers in theatre at Cleveland, O.

CONDENSERS, STEAM

Naval. Service Experience with Condensers, G. B. Allen. Shipbuilding & Shipping Rec., vol. 16, no. 14, Sept. 30, 1920, pp. 395–396; also Eng., vol. 110, no. 2856, Sept. 24, 1920, pp. 423–424, 1 fig. Analysis of causes of failure of naval condenser tubes, with suggestions as to their prevention. Paper read before Inst. of Metals.

CONDUITS

Velocity Heads. Observations on Velocity Heads with Cross-Sectional Changes in Conduits (Beobachtungen über Geschwindigkeitshöhen bei Profiländerungen in Kanälen), J. Büchi. Schweizerische Bauzeitung, vol. 76, no. 8, Aug. 21, 1920, pp. 85–88, 4 figs. Results of investigations and measurements carried out at conduit of the hydraulic plant of the Aluminum Industrial Corp. on Rhone River near Chippis.

COOLING TOWERS

Holland. On Cooling Towers, E. K. Th. van Iterson. Elecn., vol. 84, no. 2197, June 25, 1920, pp. 690–692, 4 figs. Details of construction of cooling towers at central station of pit "Emma" Dutch State Collieries, Heerlen.

COPPER

Catalytic Activity. The Catalytic Activity of Copper—I, W. G. Palmer. Proc. Royal Soc., series a, vol. 98, no. A688, Sept. 1, 1920, pp. 13–26, 3 figs. Experiments with copper prepared electrically.

Diffusion in Liquid Aluminum. Diffusion of Solid Copper in Liquid Aluminum, Robert J. Anderson. Chem. & Metallurgical Eng., vol. 23, no. 12, Sept. 22, 1920, pp. 575–577, 7 figs. Details of experiments where copper rods were dipped in molten aluminum under definite conditions, and resulting alloy analyzed. Filiation experiments also were made in various ways, all giving nearly same results.

CORROSION

Boilers. Removal of Gases from Feedwater to Reduce Corrosion of Boilers (De l'influence du dégazage sur les corrosions), Gaston Paris. Chaleur & Industrie, no. 3, May 1920, pp. 152–162, 7 figs. Tests established that removal of oxygen from feedwater by chemical means was "sole absolute remedy against corrosion."

Iron and Steel. The Influence of Copper, Manganese and Chromium and Some of their Combinations on the Corrosion of Iron and Steel, E. A. Richardson and L. T. Richardson. Gen. Meeting of Am. Electrochem. Soc., Sept. 30–Oct. 2, 1920, paper no. 13, pp. 123–125, 6 figs. Tests performed with steel, both free from and containing copper, and upon commercially pure iron, both free from and containing copper. It was found that steel rusts much faster than iron. Presence of copper, however, decreases corrosion of both iron and steel, but its action is more intense and pronounced in case of latter, so that for given amount of copper steel is actually more resistant to atmospheric corrosion than is corresponding copper-bearing iron.

COST ACCOUNTING

Fluctuations in Price. Determination of the influence of Fluctuations in Price of Materials and Labor on the Cost of Production (Bestimmung des Einflusses von Schwankungen der Materialpreise und der Löhne auf die Gestehungskosten), Hugo Baumann. Betrieb, vol. 2, no. 3, July 1920, pp. 316–319, 4 figs. It is shown how, with the aid of formulæ and curves based thereon, the influence of changes in price of material and labor on cost of production and selling price of machines, apparatus, boilers, etc., can be simply and readily determined.

Establishing Prices without Subsequent Calculation (Preisbildung ohne Nachkalkulation), Wilhelm O. Mueller. Betrieb, vol. 2, no. 3, July 1920, pp. 320–323, 6 figs. States that in a period of rapidly changing production costs the results of checking up actual costs are obtained too seldom and too late to be of great value in establishing selling prices, and a method is developed, based on weights of machines and peace-time prices of 1914, increase in cost of material and labor, and overhead costs, by which selling prices can be established.

Representation of the Occurrences in an Accounting System by Line Charts (Darstellung der Vorgänge im Abrechnungswesen durch Leitungspläne), Hans Goerlitz. Betrieb, vol. 2, no. 10, May 1920, pp. 237–243, 11 figs. States that for an intelligible representation of an accounting system it is necessary to represent the occurrences within it, and writer interprets the fluctuations of value as the flow of value currents and develops connecting-line charts accordingly. Gives example of an enterprise with detail series and mass production.

CRANKCASES

Machining Operations. Machining Operations on a Six-Cylinder and Crankcase Block, P. M. Heldt. Automotive Industries, vol. 43, no. 15, Oct. 7, 1920, pp. 712–716, 12 figs. Practice of casting top half of crankcase integral with cylinder block, first applied in connection with four-cylinder engines, has recently been adopted for six-cylinder construction. Milling and drilling work which has to be done on block in preparation for attachment of other parts is described.

CRIPPLES

Training of. See DISABLED MEN, Training of.

CUPOLAS

Blowers. Modern Two-Cupola Foundry at North Tonawanda. Iron Age, vol. 106, no. 17, Oct. 21, 1920, pp. 1042–1043, 1 fig. Cupola blower has double use, including removal of gases and smoke, in new Pierce-Brown plant.

CURRENT MOTORS

See IRRIGATION, Current Motors for.

CYLINDERS

Automobile Engines. Cylinders in the Oakland Shop, Fred H. Colvin. Am. Mach., vol. 53, no. 13, Sept. 23, 1920, pp. 571–574, 16 figs. Operations on cylinders of small six-cylinder motor in which cylinder block can be readily handled and for which special tools and fixtures have been designed.

The Essex Cylinder. Am. Mach., vol. 53, no. 13, Sept. 23, 1920, pp. 579–580, 5 figs. Machining.

The Studebaker Methods of Cylinder Production. Am. Mach., vol. 53, no. 13, Sept. 23, 1920, pp. 575–579, 17 figs. Methods of large producer of medium-size six-cylinder motors. Tools and fixtures employed are illustrated.

D

DAMS

Concrete. Using 6-in. Bank Run Aggregate on Stevenson Dam. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 638–640, 4 figs. Large size gravel dug by steam shovel from nearby pit and made into concrete chuted into place on Connecticut hydro-electric development.

Construction of. The Construction of Earth and Concrete Dams (La construction des barrages en terre et en maçonnerie). Génie Civil, vol. 77, nos. 11 and 12, Sept. 11 and 18, 1920, pp. 205–211 and 230–232, 30 figs. Survey of developments as shown in types recently built in France, Germany, Italy, Australia and United States.

Hydraulic Fill. Hydraulic Fill at the Miami Conservancy Dams—III, C. S. Hill. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 600–603, 9 figs. Discharge pipe life increased by using high carbon steel. Friction heads of 10 to 12 ft. developed in pumping heavy glacial drift.

DIESEL ENGINES

German Submarines. Modern German Submarine Diesel Engines (Neuere deutsche Unterseeboots-Dieselmaschinen), Max W. Gerhards. Motorwagen, vol. 23, nos. 14, 15, 19 and 20, May 20, 31, July 10 and 20, 1920, pp. 237–251, 264–269, 343–347 and 360–365, 46 figs. Discussion of interesting features of their construction; details of up-to-date engines of the Krupp Corp., Daimler Motor Co., Körting Bros., Ltd., German General Elec. Co., Benz & Co., etc., with diagrams showing their working efficiency.

Marine. Worthington 2,400-Horsepower Marine Diesel. Power, vol. 52, no. 13, Sept. 28, 1920, pp. 506–509, 6 figs. Engine is of vertical single acting crosshead type and has six cylinders mounted on cast-iron A-frames, which in turn are mounted on bedplate or base. General dimensions are: b.hp., 1750; mechanical efficiency, 75 per cent; bore, 29 in; stroke, 46 in.; compression, 500 lb.; injection, 900 lb.; total weight, $339^{1}/_{4}$ tons.

[See also SEMI-DIESEL ENGINES.]

DISABLED MEN

Training of. The Psychology of Industrial Convalescence, E. L. Collis. Eng. & Industrial Management, vol. 4, no. 14, Sept. 30, 1920, pp. 434–437. Treatment of physical disorders by adopting system of graduated work after initial period of rest.

DISTILLATION

Fractional. Modern Ideas of Distillation and Rectification (Idées modernes sur la distillation et la rectification), C. Berthelot. Chaleur et Industrie, no. 5, July-Aug. 1920, pp. 274–281, 7 figs. Chenard process for fractional distillation.

DOCKS

Outfitting Dock. The Outfitting Dock, Ralph L. Paddock. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 809–811, 1 fig. Chart showing length of outfitting dock required for various dock capacities and weeks of outfitting.

DRAINAGE

Diagrams for. New Diagrams for Drainage Work, J. C. D. Taylor. Can. Engr., vol. 39, no. 14, Sept. 30, 1920, pp. 383–384, 2 figs. Simplification of nomographic curves for designing ditches by Kutter's formula.

DRILLING

High Production. Continuous Production Drilling. Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 131–134, 12 figs. Methods whereby high production is obtained in drilling. Based upon practice of Baker Bros., Toledo, Ohio.

DRILLS

Pneumatic. Modern Type of Pneumatic Hand Drills (Pressluft-Handbohrmaschine neuerer Bauart), K. Rizor. Organ für die Fortschritte des Eisenbahnwesens, vol. 57, no. 11–12, June 15, 1920, pp. 115–116. Describes machines employed in the main railroad shop at Arnsberg in Westphalia which, it is claimed, greatly accelerate work in boiler shop. Their construction differs from that of usual type in that air acts on pistons which rotate in three adjoining cylinders, the cylinders themselves forming the housing.

[See also TWIST DRILLS.]

DRYDOCKS

Floating. Motors for Operating Floating Dry Docks, William H. Easton. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 794–797, 7 figs. Advantages of electric motors for operating machinery of floating drydocks.

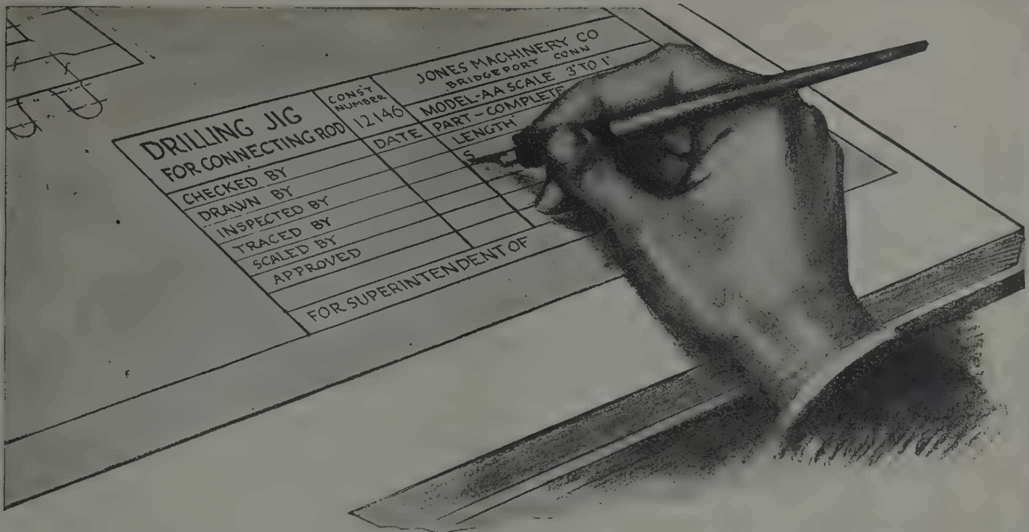
E

EARTH

Pressure. Old Earth-Pressure Theories and New Test Results, Charles Terzaghi. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 632–637, 10 figs. It is concluded from technical investigations and results obtained in experimental measurements that earth-pressure against perfectly rigid wall is fairly independent of density of backfilling. Its value for sand is expressed by means of numerical formula.

ELECTRIC CIRCUITS, A. C.

Calculation. The Power Capacity of Alternating Current Systems and a Simplified Method of Cal-



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ENGINEERING INDEX (Continued)

culating Them (Die Leistungsaufnahme von Wechselstromsystemen und ein vereinfachter Weg zur Berechnung der letzteren), F. Natalis. Elektrotechnische Zeitschrift, vol. 41, no. 26, June 30, 1920, pp. 505–508, 11 figs. A calculating method is developed, new feature of which is the representation of an inductive resistance through a vector diagram, from which very simple and clear vector equations are evolved, results of which are graphically calculated.

Electrostatically Coupled. Electrostatically Coupled Circuits, Louis Cohen. Proc. Inst. Radio Engrs., vol. 8, no. 5, Oct. 1920, pp. 434–440. Expressions of secondary frequencies, secondary current, and secondary resonance current of electrostatically coupled circuits.

Voltage Regulation. Study of the Different Systems of Regulating Voltage in Alternating Current Circuits (Étude sur les différents systèmes de réglage de la tension des réseaux à courants alternatifs), V. Sylvester Houille Blanche, vol. 19, no. 43–44, July-Aug. 1920, pp. 142–148, 14 figs. Classification and exposition of the various systems and illustrations of apparatus used.

ELECTRIC CONDUCTORS

Heating of. Heating of Electric Conductors and of Electrical Apparatus (Note sur l'échauffement des conducteurs et des appareils électriques), Adr. Curchod. Revue générale de l'Électricité, vol. 7, no. 25. June 19, 1920, pp. 819–821. Equation for equilibrium of temperature in a conductor is analyzed. Its application to numerical cases is simplified by introducing a factor termed coefficient of superficial thermal conductivity which depends on conditions of position of conductor.

ELECTRIC CURRENTS, ALTERNATING

Rectification. Advantages and Disadvantages of the Various Systems of Transformation of Alternating Current at High Tension into Direct Current (Avantages et inconvénients des divers systèmes de transformation de courant alternatif à haute tension en courant continu). Houille Blanche, vol. 19, no. 43–44, July-Aug. 1920, pp. 131–141. Based on records of operation and accidents which have taken place in various European electric railway substations. (Continuation of serial.)

ELECTRIC DRIVE

Paper Mills. Electric Drive in Paper Mills (De la commande électrique des machines à papier), M. Barbillion. Industrie Électrique, vol. 29, no. 677, Sept. 10, 1920, pp. 323–329, 2 figs. Advantages of electric drive in paper mills. Cost of installation.

Rolling Mills. Electric Drive of Rolling Mills (La commande électrique des trains de laminoirs), F. Robin. Technique Moderne, vol. 12, no. 6, June 1920, pp. 262–269, 14 figs. Relations between speed of mill and hourly tonnage of finished products Formulæ for computing power of driving motors and weight of flywheel. (Concluded.)

Electrical Equipment for 60-inch Universal Plate Mill, R. B. Gerhardt. Elec. Jl., vol. 17, no. 9, Sept. 1920, pp. 363–366, 9 figs. Description of 60-inch universal plate mill at Sparrow's Point plant of Bethlehem Steel Co., which has been in successful operation for ten weeks.

Electrically Operated Wire Rod Rolling Mill. Engr., vol. 130, no. 3376, Sept. 10, 1920, pp. 250–252, 4 figs. Mill is of semi-continuous type and was originally designed to reduce steel billet of 2 in. square section down to No. 6 S.W.G. in sixteen passes. Generating plant consists of one high-pressure horizontal type Curtiss turbine, running at 300 r.p.m., direct coupled to 1500-kw., 80 per cent power factor, 1875 kva., three-phase, 50-cycle, 2000-volt alternator.

Facts Concerning Auxiliary Drives, Gordon Fox. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct. 1920, pp. 549–550. Factors influencing selection and application of motors and control. Relations of motor to machine and work to be accomplished. (Abstract.) Paper read before Assn. Iron & Steel Elec. Engrs.

The Application of Adjustable Speed Main Drives in the Steel Mill, Gordon Fox and Arthur J. Whitcomb. Elec. Jl., vol. 17, no. 9, Sept. 1920, pp. 367–371, 11 figs. Data pertaining to installation of two rotary converter sets of constant horsepower type as installed on 10-inch continuous skelp mill built by Morgan Construction Co. and installed at Mark Plant of Steel & Tube Co. of America at Indiana Harbor, Indiana.

ELECTRIC FURNACES

Electrodes for. New Type of Carbon Electrodes for Electric Furnaces (Soderbergs selvbrændende, kontinuerlige Elektroder). Teknisk Ukeblad, vol. 67, no. 25, June 18, 1920, pp. 337–344, 8 figs. System provides for electrodes to be inserted in reinforced steel tubes, which are lengthened by fresh pieces of tubing welded on and filled with carbon as required. Electrode is baked by electric current and sinks slowly into furnace by its own weight, regulated by frictional adjustment.

Söderberg Continuous Electrodes (Les electrodes continues de Sodebert). Journal du Four electrique, nos. 13 and 14, Aug. 1–15, 1920, pp. 101–103, 4 figs. Description of Norwegian invention.

The Söderberg Self-Baking Continuous Electrode, Joseph W. Richards. Gen. Meeting of Am. Electrochem. Soc., Apr. 8–10, 1920, paper no. 1, 15 pp., 2 figs. Unbaked electrode mixture is fed continuously to furnace, mass being baked by heat of furnace in which it is being used, and apparatus is so arranged and worked that operation is practically continuous during life of furnace.

Foundry Uses. Electric Furnace as Melting Mediums, Edwin F. Cone. Iron Ages, vol. 106, no. 17, Oct. 21, 1920, pp. 1059–1061. Status as of Sept. 1 in non-ferrous and steel industries. Large expansion in former. Proportion used in foundries. Paper read before American Foundrymen's Association.

Fuel-Fired vs. Relative Thermal Economy of Electric and Fuel-fired Furnaces, E. F. Collins. Gen. Elec. Rev., vol. 23, no. 9, Sept. 1920, pp. 768–773, 5 figs. Data and cost of operation showing superiority of electric furnace.

Heat-Treating. Metallic Resistor Electric Furnaces for Heat Treating Operations, E. F. Collins. Proc. Steel Treating Research Soc. & Jl. Am. Steel Treaters Soc., vol. 2, no. 13, pp. 23–29 and p. 37, 14 figs. Performance records of General Electric furnaces.

New Electric Spring-Treating Furnaces Increase Production. Automotive Manufacturer, vol. 42, no. 6, Sept. 1920, pp. 22–23, 3 figs. Details of ovens, heated and controlled electrically as used by large Bridgeport spring company.

Nickel Chromium and the Electric Furnace. W. A. Gateward. Proc. Steel Treating Research Soc. & Jl. Am. Steel Treaters Soc., vol. 2, no. 13, pp. 16–17 and p. 37. Electric heat treating furnaces manufactured by Hoskins Manufacturing Co.

See also STEEL, HEAT TREATMENT OF, Electric Furnaces.

Installation. Report of the Electric Furnace Committee, E. T. Moore. Blast Furnace & Steel-Plant, vol. 8, no. 10, Oct. 1920, pp. 556–558. Report of Assn. Iron & Steel Elec. Engrs., giving definite recommendation covering installation on furnaces and accessories under special conditions, transformer primary voltage, reactance, and variable of dual voltage.

Regulation. Some Phenomena Observed in Electric Furnace Arcs, J. Kelleher. Gen. Meeting Am. Electrochem. Soc., Sept. 30–Oct. 2, 1920, paper no. 11, pp. 81–86, 3 figs. Experiments at University of Toronto to determine effect of slags of different compositions upon current variation caused by given movement of electrode.

Resistance Type. Electric Furnaces of the Resistance Type for Heat Treating, T. F. Bailey. Proc. Steel Treating Research Soc. & Jl. Am. Steel Treaters Soc., vol. 2, no. 13, pp. 11–15, 6 figs. Types developed by Electric Furnace Company.

Secondary Conductors. Secondary Conductors for Electric Furnaces, Edward T. Moore. Elec. Jl., vol. 17, no. 9, Sept. 1920, pp. 422–427, 12 figs. Remodeling of rocker type Héroult furnaces.

Steel Foundry. Energy Consumption in Manufacture of Castings in Electric Furnaces (La consommation d'énergie dans la fabrication des fontes au four électrique), Aimé Coutagne. Révue de Métallurgie, vol. 17, no. 7, July 1920, pp. 450–468, 3 figs. Comparison of theoretical and experimental data. Useful electrothermic effect on electric furnaces. Comparison of thermal efficiencies of electric furnace and blast furnace.

Steel-Works Installations. Heat Content of Steel and Slag from an Electric Furnace, A. M. Kuhlmann and A. D. Spillman. Gen. Meeting of Am. Electrochem. Soc., Sept. 30–Oct. 2, 1920, paper no. 17, pp. 207–210. Calorimetric determinations of heat content of liquid steel and liquid slag from six-ton Héroult steel-casting furnace. Also determinations of heat capacity of solid slag.

Wild-Barfield. Wild-Barfield Electric Furnace, Lancelot W. Wild. Chem. and Metallurgical Eng., vol. 23, no. 14, Oct. 6, 1920, pp. 699–700, 2 figs. Furnace consists of refractory lining which is wound with helix of nickel-chrome wire. Case is made of sheet aluminum, with cast-iron stand and cast-iron top and doors. Furnace is manufactured primarily for heat treatment of steel.

ELECTRIC GENERATORS

Temperature Detectors. Embedded Temperature Detectors in Large Generators, F. D. Newbury and C. J. Fechheimer. Elec. Jl., vol. 17, no. 9, Sept. 1920, pp. 410–418, 11 figs. Tests with armature model. Method of installing detector.

ELECTRIC GENERATORS, A. C.

Design. Factors Determining Generator Design, F. D. Newbury, R. B. Williamson and W. J. Foster. Elec. World, vol. 76, no. 16, Oct. 16, 1920, pp. 779–783, 8 figs. Principal dimensions and weights of 32,500-kva., 12,000-volt, three-phase, 25-cycle, 150-r.p.m., Westinghouse waterwheel-driven generators installed in new 100,000 hp. extension of Niagara Falls Co.

ELECTRIC GENERATORS, D. C.

High-Voltage. The Operation and Stress of Direct-Current High-Voltage Generators in the Operation of Radio Transmitters (Ueber die Arbeitsweise und Beanspruchung von Gleichstrom-Hochspannungsmaschinen beim Betrieb von Funkensendern), Karl Wagner. Elektrotechnische Zeitschrift, vol. 41, nos. 30 and 31, July 29 and Aug. 5, 1920, pp. 581–585 and 605–609, 20 figs. Theoretical and experimental investigation of the occurrences in a d. c. generator for 10,000 volts in the operation of a radio transmitter with rotating spark gap, results of which show that the insulation of generator is stressed by resonance phenomena, traveling waves and by phenomena in connection with transmission interruption. Shows how resonance excess voltage can be entirely eliminated, the circuit-breaking excess voltages considerably reduced, and the traveling waves greatly damped.

Pole-Face Leakage. The Calculation of the Pole Face Leakage of Direct-current Armatures for the Determination of the Commutation Voltage (Die Berechnung der Stirnstreuung von Gleichstromankern für die Ermittlung der Stromwendespannung), Franz Unger. Elektrotechnische Zeitschrift, vol. 41, no 32, Aug. 12, 1920, pp. 627–630, 8 figs. Gives equations for calculating leakage conductivity per cm. length of conductor.

ELECTRIC LAMPS, INCANDESCENT

Watertight Fittings. British Standard Specification for Watertight Fittings for Incandescent Electric Lamps. British Eng. Standards Assn., no. 97, 1920, 33 pp., 38 figs. Specifications approved on Aug. 5, 1920.

ELECTRIC LOCOMOTIVES

Driving Gear. The Mechanical Driving Gear of Electric Trunk Line Locomotives (Das mechanische Triebwerk elektrischer Vollbahnlokomotiven), E. E. Seefehlner. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 38 and 40, Sept. 18 and Oct. 2, 1920, pp. 761–766 and 815–817, 49 figs. Fundamental peculiarities of drives with underframe or upper-frame motors; axle motor, transmission motor and flexible transmission; parallel crank gear with and without geared transmission, etc.; loose shaft with parallel crank gear; the Kando coupling frames, double-rod drive with and without loose shaft; etc.

Overloads on Motor Armatures. Effect of Short-Time Overloads on Railway Motor Armatures, J. K. Stotz. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 473–474, 2 figs. Graphs showing comparative temperature rises on field coils of ventilated and non-ventilated motors having same continuous capacity.

Repair Costs. The Logical Unit for Comparing Repair Costs of Electric Locomotives and Cars, Hugh Pattison. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 475–477. Kilowatt-hour input to locomotive or car is thought to be much more correct and convenient unit than locomotive-mile or train-mile units.

Slip Arrester. A Slip Arrester for Heavy Electric Locomotives, C. C. Whittaker. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 446–447, 5 figs. Device automatically removes torque from or decreases it on axle slipping, instant after slipping occurs.

Swiss Federal Railways. The 1B + Bl Alternating Current locomotives for the Bernese Railways (Die 1B + Bl Wechselstrom-Lokomotiven für die Bernischen Dekretsbahnen). Schweizerische Bauzeitung, vol. 76, no. 8, Aug. 21, 1920, pp. 83–84, 2 figs. Brief particulars of new 2-4-4-2 single-phase locomotives constructed on similar lines to all the locomotives of Swiss Federal Railway.

[See also LOCOMOTIVES, Diesel-Electric.]

ELECTRIC MOTORS

Installation. Lining up a Motor for Shafting or Machine Drive, K. A. Reed. Power, vol. 52, no. 12, Sept. 21, 1920, pp. 459–461, 4 figs. How to install motor on ceiling, wall or floor and line it up to shafting is explained and methods of handling motor during installation are given.

ELECTRIC MOTORS, A. C.

Induction. Induction Motor Core Losses, P. L. Alger and R. Eksergian. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 10, Oct. 1920, pp. 906–920, 17 figs. Writers subdivide core losses into six elements and point out that only one of six is ordinarily calculated by designing engineers, with resulting large discrepancies between expectation and fact. Belief is expressed that to calculate other elements approximately is entirely feasible and that such calculations would explain most of variations in core loss now attributed to imperfections in manufacture. Formulæ are developed for losses in core back of teeth, which are found to give larger values than more approximate formulæ now in use and conclusions are presented in form of charts giving correction factors to apply to usual formulæ for all ordinary conditions.

Reconnecting Two-Phase Induction Motors, A. C. Roe. Elec. World, vol. 76, no. 14, Oct. 2, 1920, pp. 683–684, 30 figs. on supp. plate. Tables and winding diagrams giving information necessary for connecting two-pole to twelve-pole motors.

ELECTRIC MOTORS, D. C.

Mine Installations. Treatment of Direct-Current Motors for Mining Conditions, T. H. Arnold. Power, vol. 52, no. 15, Oct. 12, 1920, pp. 582–583, 2 figs. Advises dipping and baking armatures in field coils systematically. Dipping and baking process is described.

Variable-Voltage. Direct-Current Motors for Highly Variable Voltage (Gleichstrommotoren für stark veränderliche Spannung), H. Roth. Elektrotechnische Zeitschrift, vol. 41, no. 27, July 8, 1920, pp. 525–528, 9 figs. Investigation of the behavior of direct-current motors when impressed with variable voltage of from 220 to 330 volts and how, in spite of this great variation in voltage, it is possible to construct motors with unvarying speed by means of differential winding.

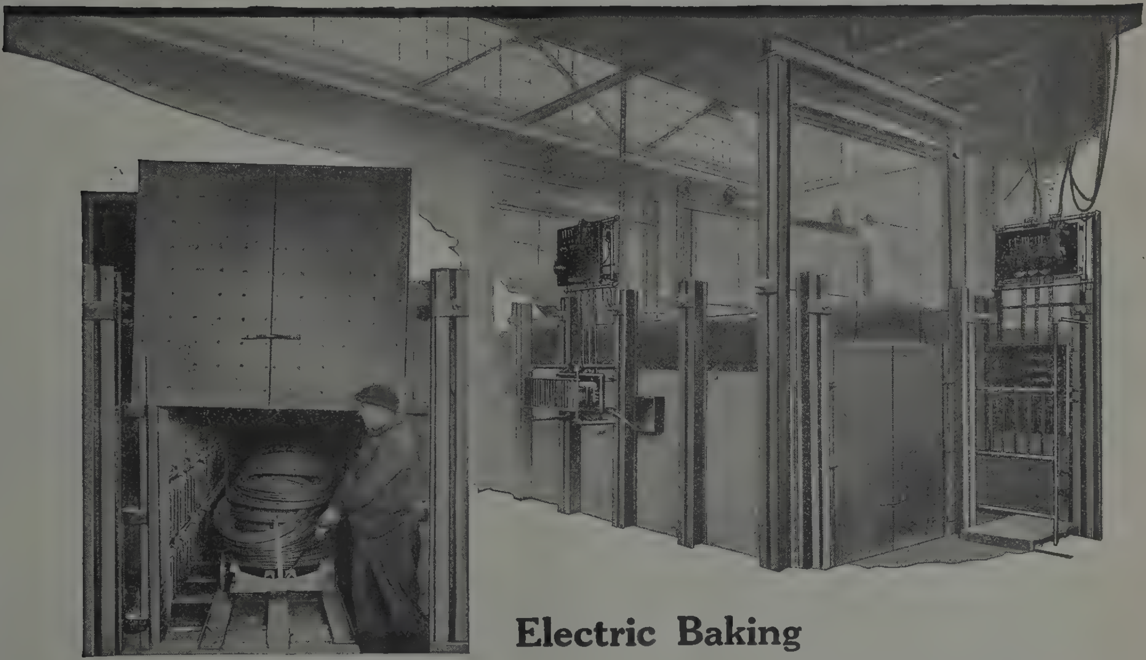
ELECTRIC PLANTS

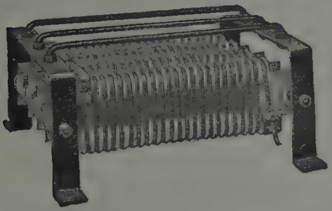
Load Factor. The Measurement of Maximum Demand and the Determination of Load Factor, Perry A. Borden. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 10, Oct. 1920, pp. 875–887, 14 figs. Determination of load factor with a view to rate making. Survey of present situation. Comparison of performance of a number of demand-measuring devices.

ELECTRIC RAILWAYS.

Braking, Regenerative. Electric Braking of Direct-

Electric heat, ever ready to serve and easy to control, reduces to a minimum the rejections in industrial baking





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ENGINEERING INDEX (Continued)

Current Vehicles, W. M. Hutchinson. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 471–473, 5 figs. Fundamental principles involved.

The Recovery of Current with Alternating Current Railways (Stromrückgewinnung bei Wechselstrombahnen), M. Schenkel. Elektrotechnische Zeitschrift, vol. 41, nos. 28 and 29, July 15 and 22, 1920, pp. 542–544 and 567–571, 26 figs. Discusses advantages and disadvantages of regenerative braking with aid of practical examples. Notes on elimination of self-excitation phenomena and creation of a good power factor. Curves showing operating characteristics of the different connections, indicating especially how tractive power, power factor and efficiency vary with speed and the influence of voltage regulation on main transformer of alternating current locomotive.

Multiple-Unit Train Operation. Multiple-Unit Control Equipments, H. R. Meyer. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 464–469, 14 figs. Types used on Cleveland Interurban Railway Co.

Multiple-Unit Train Operation, S. B. Schenck. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 457–460, 6 figs. Types of multiple-unit controls.

Operation. The Scientific Arrangement of Schedules, Edward Dana. Elec. Ry. Jl., vol. 56, no. 14, Oct. 2, 1920, pp. 647–651, 7 figs. Close relation of efficient schedules to economical operation. Eight-hour-day problem as worked out on Boston Elevated Railway.

Protection of Electrical Equipments. Methods of Protecting Electrical Equipments, Lynn G. Riley. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 453–456, 12 figs. Methods of protecting electrical equipments on cars and locomotives.

ELECTRIC SWITCHES

Oil. Oil Circuit Breaker Arrangements and Switching Schemes for Steel Mills, G. P. Wilson. Elec. Jl., vol. 17, no. 9, Sept. 1920, pp. 402–410, 15 figs. Schematic diagram of power plants and mill equipment located in five separate mills of one large company.

Oil Switches for Large Electrical Supply Systems. Engr., vol. 130, no. 3375, Sept. 3, 1920, pp. 220–222, 9 figs. Critical study of present designs.

The Phenomena of Switching in Oil and the Possibilities of Standardizing the Apparatus, P. Charpentier. Elecn., vol. 84, no. 2196, June 18, 1920, pp. 668–670. Paper read before Union des Syndicats de l'Électricité. This organization is about to draw up standard rules for oil switching apparatus. Lines along which standards are practicable are discussed in article. Translated from Revue Electrique.

ELECTRIC TRANSMISSION

Long-Distance, Power Required. The Power Required for Long Distance Transmission. Radio Rev., vol. 1, no. 12, Sept. 1920, pp. 598–608, 8 figs. Formulæ and graphs. Distances considered are 1000, 2000, 3000, 5000 and 10,000 km.

ELECTRIC TRANSMISSION LINES

Automatic Protective Devices. Automatic Protective Devices for Alternating-Current Systems, A. E. McColl. Jl. Instn. Elec. Engrs., vol. 58, no. 293, July 1920, pp. 525–543 and (discussion) pp. 543–554, 40 figs. Survey of recent developments.

Economics of. Economic Study of Secondary Distribution, P. O. Reyneau and Howard P. Seelye. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 10, Oct. 1920, pp. 861–874, 13 figs. Problems taken up are (1) new lines in thinly populated districts where load will probably build up rapidly, (2) old lines in residence districts well built up where revision is necessary to care for slowly increasing load, (3) old lines in districts with heavy, increasing load such as business districts, and (4) exceptional installations such as for permanent loads with no increase or for a decreasing load. Equations and curves are derived and constructed and their application explained.

High-Tension. Calculation of Electric Transmission Lines by Means of Vectors Representing Real Quantities (Sur le calcul des lignes électriques par l'emploi de fonctions victorielles en notations réelles), André Blondel. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 11, Sept. 13, 1920, pp. 504–509. Suggests system of computing elements of high tension electric transmission lines without introducing imaginary quantities.

Reactance of Line. Graph for Computing Reactance of an Electric Line (Abaque pour le calcul de la réactance des lignes electriques), R. Valensi. Revue génerale de l'Électricité, vol. 8, no. 10, Sept. 4, 1920, pp. 313–314, 1 fig. Linear diagram constructed from general formula. Frequency of 50 is assumed.

Three-Phase. The Electrical Properties of Three-Phase Transmission Lines, E. Parry. English Elec. Jl., vol. 1, no. 2, April 1920, pp. 54–68, 4 figs. Compilation of tables and data for use of departmental offices in designing transmission lines.

ELECTRIC WELDING, ARC

Strength of Joint. Notes on Electric Welding, Henry S. Rawdon and O. H. Eschholz. Mech. Engr., vol. 42, no. 10, Oct. 1920, pp. 567–574, 21 figs. Electric welding of steel. Data on strength of joint and properties of arc-fused metal. Papers read before Washington Section of Am. Soc. Mech. Engrs.

ELECTRIC WELDING, RESISTANCE

Percussive Welding. Developments in Electro-Percussive Welding. Iron Age, vol. 106, no. 17, Oct. 21, 1920, pp. 1040–1041, 6 figs. Quantity production of duplicate parts. Dissimilar metals joined and cutting tools attached to low grade shanks. Paper read before American Welding Society.

ELECTRICAL MACHINERY

Cooling of. Cooling of Electric Machines of High Power (Refroidissement de machines électriques de grande puissance), P. Bunet. Revue générale de l'Électricité, vol. 8, no. 10, Sept. 4, 1920, pp. 314–320. Proposes cooling system in which suitable volatile liquids are carried over parts to be cooled, allowed to evaporate there and then removed and condensed, following methodical cycle. Scheme provides also for utilization of heat removed from electric machine.

ELECTRODES

See ELECTRIC FURNACES, Electrodes for.

ELECTROPLATING

See BRASS, Electric Deposition of.

ELECTROTECHNICS

Bi-Symbolic Equations. Bi-Symbolic Equations and their Employment in Electrotechnology (Bi-symbolische Gleichungen und deren Verwendung in der Elektrotechnik), August Hund. Elektrotechnik u. Maschinenbau, vol. 38, no. 26, June 27, 1920, pp. 289–293, 3 figs. Writer refers to symbolic expression by Steinmetz and Kennelly and seeks to show that when both are properly applied, complicated problems relating to forced as well as free oscilliatons can be solved according to a method similar to algebraic process.

EMPLOYEES

Shop Magazines for. Gaging Employees' Magazine Results, John T. Bartlett. Am. Mach., vol. 53, no. 13, 1920, pp. 589–591. Writer tells of means of estimating results obtained by means of such papers, and also of means of getting results through them.

EMPLOYMENT MANAGEMENT

Interviewing Applicants. The Art of Interviewing, R. T. Fennell. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 310–311. Requirements of successful interviewing.

The Art of Interviewing Applicants, Russell J. Waldo. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 273–277, 14 figs. Procedure followed in employment department of representative firms. System of keeping records of applicants.

Methods of Hiring Men. Methods of Hiring and Training Men, Henry S. Day. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 447–451, 6 figs. Methods used by Mechanical Department of Kansas City Railways.

ENGINEERING SCHOOLS

Coöperative Course. A new Coöperative Course in Electrical Engineering, W. H. Timbie. Gen. Elec. Rev., vol. 23, no. 9, Sept. 1920, pp. 784–790. Coöperative course given by General Electric Co. and Massachusetts Institute of Technology. Practical training is given in six thirteen-week periods during last three years of five-year course.

ENGINEERING SOCIETIES

Federated American Engineering Societies. Am. Soc. C. E. Arguments for and Against Federation. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 663–665. Membership receives presentation of opposing views prior to voting on question of joining the new organization.

ENGINEERS

Civic Activities, Italy. The National Convention of the Italian Engineers at Naples (Il convehno nazionale degli ingegneri italiani a Napoli). Associazione nazionale degli Ingegneri italiani Giornale ufficiale, vol. 1, no. 21, July 30, 1920, pp. 157–161. Summary of proceedings of National Convention of Italian Engineers held at Naples, May 20 to 25, 1920. One of topics discussed was, "Civic Activities of Engineers."

Participation in Civic Affairs. Responsibilities of Technical Men and Obligations of the People, Warren G. Harding. Chem. Age (N. Y.), vol. 28, no. 9, Sept. 1920, pp. 309–310. Opinion is expressed by writer that "representatives of the engineering professions should sit in our state and national legislative bodies, instead of being merely the administrative agents of the great engineering projects that our intensive civilization now demands shall have greater fruition."

EXCAVATION, EARTH

Dragline Installation. Excavating for Ballast in England, R. G. Burdett. Excavating Engr., vol. 14, no. 8, Oct. 1920, pp. 263–265, 5 figs. Description of an unusual dragline installation in England. Mining ballast in 17 ft. of water. Loading into cars on trestle 20 ft. above ground level. Output of ton per minute has been attained.

EXECUTIVES

Training of. How to Develop Executive Ability, John H. Van Deventer. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 260–264, 2 figs. Writer holds that executive ability is invariably developed by following, either consciously or unconsciously, a plan of organization which liberates creative effort through establishment of automatic routine. Plan of organization modulated after that of human body is worked out.

Women as. The New Place of Women in Industry, Ida M. Tarbell. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 265–266. Economic significance of entrance of women workers in industry. Women as executives.

EXPLOSIVES

Handling. The Menace of Opening Kegs of Black Blasting Powder with Wooden Tools, S. P. Howell. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2161, Sept. 1920, 3 pp. Details of three accidents in which kegs of black blasting powder exploded instantly when wooden tool was driven forcibly through top of kegs.

Liquid Oxygen. Data Concerning Use of Liquid Oxygen Explosives in Germany, George S. Rice. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2163, Sept. 1920, 2 pp. Total of 136 plants is mentioned, with total capacity of 3797 liters of liquid oxygen per hour.

Safety Device. Removable Auger Bit as a Safety Device. Coal Age, vol. 18, no. 15, Oct. 7, 1920, pp. 739–742, 5 figs. Forcing cartridge into hole too small for it and carrying drills out to blacksmith for reshaping are dangerous. Hard, detachable drill points, used in new types, are said to obviate both risks.

EXPORT TRADE

Oriental Countries. Opportunity for America in the Orient, Herbert A. Andresen. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct. 1920, p. 569. Ideas and suggestions based on writer's personal contact with eastern countries. Address delivered before Pittsburgh Advertising Club.

Steel. Export Trade's Relation to Steel, E. A. S. Clarke. Iron Trade Rev., vol. 67, no. 13, Sept. 23, 1920, pp. 857–858. Important international commerce of exports of manufacturers is stressed. From pamphlet "Sources of Our Exports" issued by Nat. Foreign Trade Council.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FERTILIZERS

See BLAST-FURNACE GAS, Use as Fertilizer.

FIR

Douglas. Inclined-Bearing Tests on Douglas Fir and White Pine, Thomas R. Simpson. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 654–655, 4 figs. Results of tests are plotted together with terminal values as computed from Jacoby and Howe formulæ. It was found in investigations that loads for 0.03-in. indentation correspond closely with Howe curve.

FLIGHT

Soaring. Soaring Flight (Le vol à voile), H. Liurette. Nature (Paris), no. 2419, Aug. 14, 1920, pp. 109–112, 6 figs. Mechanical theory of forces acting.

Tail Plane, Setting of. A Method for Determining the Angular Setting of a Tail Plane to Give Balance at any Given Condition. Air Service Information Circular, vol. 2, no. 102, Aug. 15, 1920, 7 pp. Method includes determination of proper angular setting of horizontal tail plane to give longitudinal balance at following flight conditions: (1) level flight at any speed, (2) climbing flight at best rate of climb, (3) gliding at any angle with power off and (4) conditions (1), (2) and (3) at any altitude.

FLOOD PROTECTION

Creek-Channel Diversion. Flood Protection Project for Council Bluffs. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 596–598, 3 figs. Diverting creek from present channel through city and discharging into Missouri River near upper end of Council Bluffs, Ia., is method of protection against flood in creek.

FLOTATION

Machines. The Du Faur Flotation Machine, B. Du Faur. Chem. Eng. Min. Rev., vol. 12, no. 143, Aug. 5, 1920, pp. 395–398, 2 figs. Patented machine designed for recovery of copper contents of roasted pyrites carrying copper and zinc.

Testing Ores for. Testing Ores for Flotation, James M. Hyde. Min. & Sci. Press, vol. 121, no. 14, Oct. 2, 1920, pp. 481–486, 8 figs. Pneumatic machine for continuous testing.

Theory of. A Résumé of Literature on the Theory of Flotation with Critical Notes, H. R. Adam. Jl. Chem. Metallurgical & Min. Soc. of So. Africa, vol. 21, no. 2, Aug. 1920, pp. 17–24. Summary of principles set forth in text books and technical articles in magazines during last five years.

FLOW OF LIQUIDS

Whirles through Orifice. Perrot's Experiment Relative to Rotation of the Earth (Sur l'expérience de Perrot relative au mouvement de rotation de la Terre), Joseph Rey. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 6, Aug. 9, 1920, pp. 343–344. According to Perrot, when a liquid at rest in a cylindrical container starts flowing through orifice in center of bottom, whirles are produced in mass of liquid which bear definite relation to earth's rotation. Writer of present note reports that in numerous experiments he performed he was unable to confirm Perrot's contention.

FLOW OF OIL

Pipes. The Flow of Oil in Pipes, Arthur C. Preston. Chem. & Metallurgical Eng., vol. 23, nos. 13 and 14, Sept. 29 and Oct. 6, 1920, pp. 607–613 and 685–689, 4 figs. General method for determining friction loss of any liquid from its saybolt viscosity; with tables for pipes from 1 to 6 in. in diameter.

FLOW OF WATER

Channels. Hydraulics of the Chicago Sanitary

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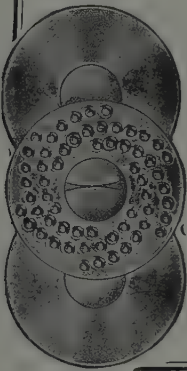

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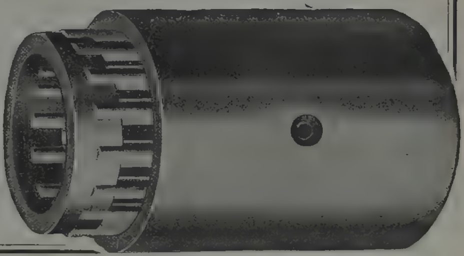

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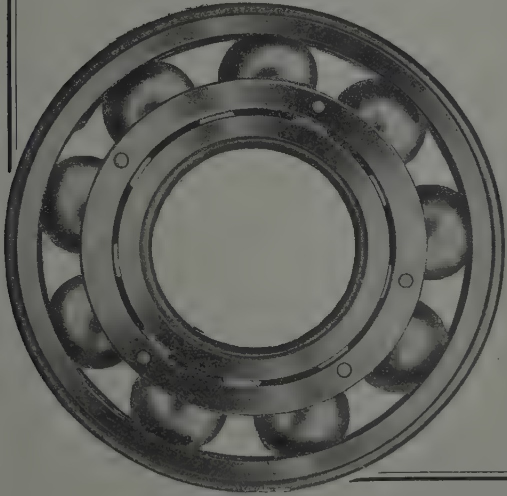

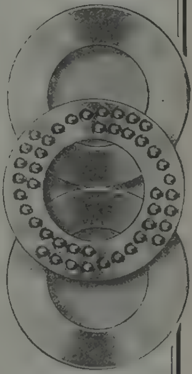

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ENGINEERING INDEX (Continued)

District's Main Channel, Murray Blanchard. Jl. Western Soc. Engrs., vol. 25, no. 13, Sept. 5, 1920, pp. 471–524, 30 figs. Investigation of flow of main channel covering period of three years, 1914–1916 and part of 1917. Work involved series of current meter measurements extending over entire time in order to obtain sufficient range in stage of Lake Michigan in connection with varied stages at Lockport Power House, to give variety of conditions at uniform flow from which law of flow in rock section below Willow Springs could be derived.

Orifices. Flow of Water through Orifices (Sur le régime permanent dans les chambres d'eau), C. Camichel. Revue générale de l'Électricité, vol. 8, no. 11, Sept. 11, 1920, pp. 331–338, 16 figs. Flow of water out of tank through orifice at bottom was studied by photographing at various times positions of particles in suspension which reflected light from adequately located source. From results obtained existence of equipotential surfaces of velocity throughout mass of water is established and formulæ are developed to express distribution of velocities.

FOREMEN

Training of. Foremen that were Bosses are now Leaders, Arthur H. Young. Factory, vol. 25, no. 7, Oct. 1, 1920, pp. 1035–1037, 2 figs. Course for training foremen as developed by International Harvester Co.

How to Become a Successful Shop Executive, Paul R. Ramp. Iron Age, vol. 106, no. 14, Sept. 30, 1920, pp. 823–826. Sample working schedule for foundry foreman is suggested, and various types of workmen are classified and how to deal with them pointed out.

FORGING

Hydraulic Press. An Investigation of Various Forging Operations Carried out under Hydraulic Presses, Eugène Schneider. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 12, 36 pp., 12 figs. partly on 3 supp. plates. Schneider apparatus for recording times and pressures employed during forging, in relation to stroke. Designed by Forge Department of Creusot Works.

FOUNDATIONS

Three-Column. Analysis of the Continuous Three-Column Foundation, Charles A. Ellis. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, pp. 680–682, 5 figs. Distribution of base pressure controlled by continuity of main grillage girders. How correct lengths of girder projections are computed. Special case of limited projection.

FOUNDRIES

Conveyors for. Increased Foundry Production by Conveyors, Iron Age, vol. 106 no. 14 Sept. 30, 1920, pp. 831–833, 5 figs. Savings in time, space and materials, coupled with greatly increased production are said to have resulted from installation of system of conveyors in No. 2 foundry of Hamilton Foundry & Machine Co., Hamilton, Ohio.

Equipment. Exhibits Show Trend in Design. Iron Trade Rev., vol. 67, no. 15, Oct. 7, 1920, pp. 1007–1011, 7 figs. Developments in model and construction of machine tools, molding machines, handling equipment and furnaces as evidenced by 225 exhibits shown in connection with meeting of Am. Foundrymen's Assn. at Columbus, Ohio.

Industrial Trucks for. Cupola Metal Conveyed by Electric Trucks. Iron Age, vol. 106, no. 14, Sept. 30, 1920, pp. 827–830, 7 figs. Plant of Elmira Foundry Co. for small castings predominant feature is use of electric storage battery trucks for handling of molten metal and castings, electric traveling cranes being eliminated with exception of one crane in cleaning department.

Labor-Saving Devices. Labor-Saving Foundry Innovations Planned, Edwin A. Hunger. Iron Age, vol. 106, no. 17, Oct. 21, 1920, pp. 1031–1035, 4 figs. Among features of foundry being built by Lycoming Motors Corporation, Williamsport, Pa., maker of automobile engines, are mentioned carousel and apron conveyors and monorail system to facilitate casting of automobile motors, core-oven room ventilation, and unusual sandblast cabinet.

Pouring Methods. Labor-Saving Methods in the Foundry, Peter F. O'Shea. Am. Mach., vol. 53, no. 17, Oct. 21, 1920, pp. 763–764. Methods of pouring used in different classes of work in factory of Chapman Valve Mfg. Co.

Steel. Plan Shop with View to Extensions. Foundry, vol. 48, no. 19, Oct. 1, 1920, pp. 757–762, 9 figs. Steel foundry designed so that its present capacity can be more than quadrupled with little disturbance. Basic lining chosen for electric furnace. Castings conveyed in special boxes.

FUELS

Evaluation of. Determination and Evaluation of Fuels from the Combustion Temperatures (Beurteilung und Bewertung der Brennstoffe nach den Verbrennungstemperaturen), Wilhelm Schwier. Stahl u. Eisen, vol. 40, nos. 33, 35 and 37, Aug. 19, Sept. 2 and 16, 1920, pp. 1108–1111, 1170–1177 and 1236–1240. From determination of the combustion temperatures and values of a number of fuels, the influence of the combustion temperatures on capacity and fuel consumption of furnaces is established, and a general value coefficient for the determination and evaluation of fuels is recommended. (Concluded.)

Mixed. Recent Patents on Mixed Fuels. W. R. Ormandy. Jl. Inst. Petroleum Technologists, vol. 6, no. 23, July 1920, pp. 229–239 and (discussion) pp. 239–248. Critical examination of patents granted by British Patent Office. Only minor details in patents, such as addition of denaturant to liquid fuel saturated with gas, are considered as novel, patents being described as mixtures of liquid fuels which every scientist knows will burn in almost any proportions.

FURNACES, ANNEALING

Evolution. Sheet, Pair and Annealing Furnaces—II, C. F. Poppleton. Iron Age, vol. 106, no. 13, Sept. 23, 1920, pp. 770–772, 2 figs. Evolution from earlier types to continuous pair furnace. Details of an in-and-out annealing furnace.

FURNACES, BOILER

Design. Adaptation of Combustion Chamber to the Different Fuels and Influence of Radiation on Combustion (Appropriation de la chambre de combustion aux différents combustibles et influence du rayonnement), P. Perdrizet. Chaleur & Industrie, no. 3, May 1920, pp. 163–172, 11 figs. Tests made to study influence of heat radiation on combustion in various types of boilers.

Low-Grade Fuels. Utilization of Low-Grade Fuels in Boiler Operation (Verwertung minderwertiger Brennstoffe im Kesselbetrieb), Heinrich Reiser. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 30, 31 and 33, July 23, 30 and Aug. 13, 1920, pp. 225–227, 235–236 and 251–253, 9 figs. Notes on the various construction types of forced draft horizontal grates and traveling grates, with comparative tests. Recommendations for stoking with very low-grade fuels; gas film furnaces; traveling grates for flue boilers, extension and internal furnaces; the economy of gasification of coke breeze as compared with direct combustion under the boiler.

Progress. New Patents on Boiler Furnaces (Neue Patente auf dem Gebiete der Dampfkesselfeuerung) A. Pradel. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 28 and 29, July 9 and 16, 1920, pp. 209–212 and 219–221, 20 figs. Quarterly report of domestic and foreign patents.

FURNACES, HOT-AIR

Tests. Emissivity of Heat from Various Surfaces with Special Reference to Warm-Air Furnace Installations, V. S. Day. Univ. of Illinois Eng. Experiment Station, bul. no. 117, Jan. 1920, 39 pp., 10 figs. Results of comparative tests on covered and uncovered sheet metal surfaces made in connection with warm-air furnace investigation.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

G

GAGES

Calibration. The Calibration of Dimensional Changes of Precision Gage Blocks, C. G. Peters and H. S. Boyd. Am. Mach., vol. 53, nos. 14 and 15, Sept. 30, and Oct. 7, 1920, pp. 627–632 and 674–679, 20 figs. Sept. 30: How planeness and parallelism errors of precision surfaces in gage blocks are determined; and Oct. 7: Comparison of gages by means of light waves. Tables and charts showing results of experiments.

Inspection of. Precision Measuring and Inspection Devices, R. J. Whibley. Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 135–139, 10 figs. Optical methods developed at British National Physical Laboratory, for facilitating inspection.

Thread. Standard Thread Gages (Normal-Gewindelehrdorne), Jos. Reindl. Betrieb, vol. 2, no. 13, July 1920, pp. 313–315, 12 figs. States that with thread gages a cylindrical shank for measurements of the nut boring should suffice. The construction of thread gages with measurements of the Whitworth screw tap with center play is not feasible; for manufacture of accurate threads, standard thread gages do not suffice, special gaging devices being required for certain measurements.

The Hardening of Screw Gages with the Least Distortion in Pitch—II, Wilfrid J. Lineham. Am. Mach., vol. 53, no. 13, Sept. 23, 1920, pp. 604a–604d, 14 figs. It is concluded from experiments that hardening screw gages in oil, after casing in cyanide can be performed with less distortion than if water is the quenching medium: Temperature of 717 deg. cent. (1323 deg. fahr.) is considered best heat for quenching. It is held that by screwing gages to accurate pitch and to diameters at two-thirds below high limit and one-third above low limit, lapping can be dispensed with.

The manufacture of Hardened Screw Gages. Engr., vol. 130, no. 3378, Sept. 24, 1920, pp. 310–311, 5 figs. Manufacturing process followed at plant of Coventry Gauge & Tool Co., Coventry, England.

GARAGES

Concrete. Concrete Cantilever Construction in Chicago Garage. Eng.-News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 609–611, 3 figs. Single and double cantilever beams support 11-ft. span of floor and roof slab and carry 50-ft. monitor trusses.

GAS

Calorific Value. Advantages of a Reasonable Standard of Calorific Value for City Gas—Experiences in Canada, Arthur Hewitt. Am. Gas Light Assn. Monthly, vol. 2, no. 10, Oct. 1920, pp. 595–598, 1 fig. Minimum calorific standard of 450 B.t.u. was fixed by Canadian government as temporary measure in Nov. 1919, and was to be continued for a period of four months. Results realized are said to have been "most satisfactory to all interests concerned."

The Quality of Gas in Massachusetts. Gas World, vol. 73, no. 1888, Sept. 25, 1920, pp. 227–228. Calorific standard of minimum of 528 B.t.u. was established by Board of Gas & Elec. Light Commissioners in Dec. 1917. Encouraging results are being obtained. From official report of Board.

GAS ENGINES

Governing. Stabilized Governing, Oscar C. Roos. Sci. Am. Monthly, vol. 2, no. 2, Oct. 1920, pp. 141–144, 9 figs. "Dead beat" governor for autotruck radio plants.

GAS MAINS

Submerged. Laying Submerged Gas Mains, D. L. Hill. Gas Age, vol. 46, no. 6, Sept. 25, 1920, pp. 213–215, 1 fig. Particulars of various submerged mains, notably Astoria 72-in. double line, Toronto 12-in. line, and 36-in. water main across Narrows, New York Harbor.

[See also MOLDING METHODS, Large Gas Mains.]

GAS MANUFACTURE

Regenerator vs. Recuperator. Regenerator vs. Recuperator and the Kiel Recuperative Furnace Plant (Regenerator gegen Rekuperator und die Kieler Gleichzugofenanlage), O. Friese. Jl. für Gasbeleuchtung u. Wasserversorgung, vol. 63, no. 33, Aug. 14, 1920, pp. 525–527, 1 fig. From results of two years of operating experience with a horizontal recuperative furnace plant at Kiel, writer claims to have demonstrated the superiority of the recuperative furnace over the regenerative furnace for the manufacture of illuminating gas, provided both systems are operated under equally favorable conditions—that is, in connection with a central generator.

GAS PRODUCERS

Mechanical. Smith Mechanical Gas Producer. Power, vol. 52, no. 15, Oct. 12, 1920, pp. 572–573, 2 figs. Type of gas producer in which fuel is distributed mechanically over bed and poking done automatically, developed by Smith Gas Engineering Co., Dayton, Ohio.

Tar Recovery in. The Recovery of Fuels at Low Temperatures (Die Entstehung der Brennstoffe bei tiefen Temperaturen), H. Gwodz. Oel- u. Gasmaschine, vol. 17, no. 8, Aug. 1920, pp. 119–125, 7 figs. Details of various patented gas producers provided with tar-recovery apparatus.

GAS TURBINES

Practicability of. The Problem of the Gas Turbine and its Industrial Consequences (Le problème de la turbine a gaz et ses conséquences industrielles), Marcel de Coninck. Technique Moderne, vol. 12, no. 6, June 1920, pp. 250–262, 19 figs. Industrial practicability of gas turbines is demonstrated in comprehensive technical study of its thermal characteristics. Structural details are visualized.

GAS WORKS

Ottawa. Modern Gas Plant at Ottawa, A. A. Dion. Gas Age, vol. 46, no. 6, Sept. 25, 1920, pp. 209–212, 6 figs. Coal carbonizing plant was designed for ultimate capacity of 6,000,000 cu. ft. per day, in four self-contained units of 1,500,000 cu. ft. Yield of 16,000 cu. ft. per short ton has been obtained with low-grade coals.

GASES

Dust Precipitation in. A New Electrical Precipitation Treater, Motoji Shibusawa and Yasujiro Niwa. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 10, Oct. 1920, pp. 890–903, 35 figs. Treater, as in case of modern type, consists of metal cylinder as passive electrode and metal wire suspended along center of cylinder as active electrode; only difference being that electrodes in their treater are entirely separated with dielectric substances such as glass, porcelain, etc. Treater was developed as result of experience at Electrotechnical Laboratory in Tokyo, Japan, and has been recently applied to treater at Nikko Copper Refining Works. Theory of new treater is given in detail.

GASOLINE

Recovery from Natural, Gas. See NATURAL GAS, Gasoline Recovery from.

Situation in U. S. The Gasoline Situation, R. L. Welch. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 353–355. Statistics regarding oil production and consumption in U. S.

Substitutes for. New Gasoline Substitute an Alcohol Derivative. Automotive Manufacturer, vol. 42, no. 6, Sept. 1920, pp. 24 and 26. Fermogas, manufactured by Fermogas Corporation, New York. It is described as specially denatured alcohol wherein denaturizing agent is petroleum or coal tar derivative.

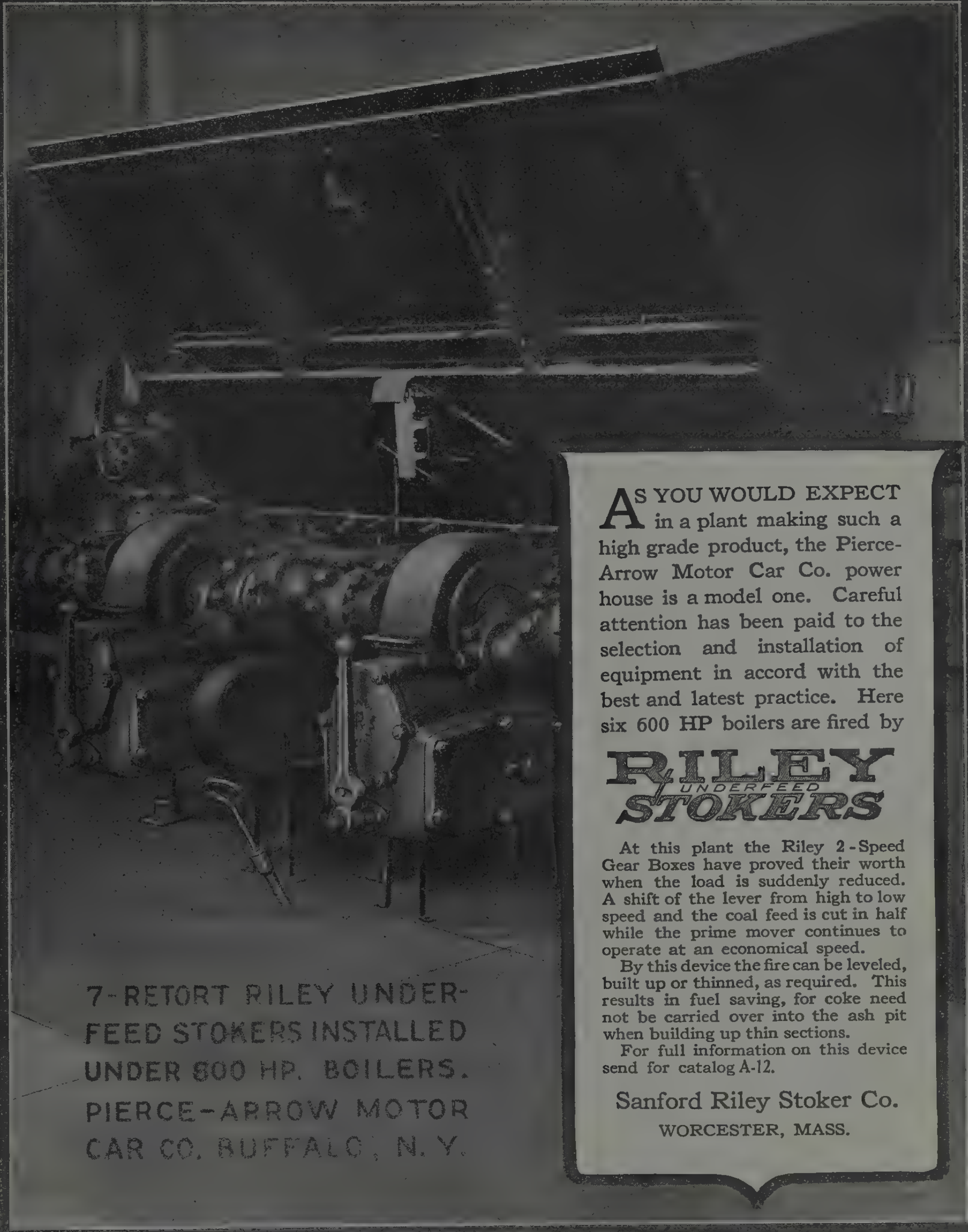
GASOLINE ENGINES

Centrifugal Oil Cleaner. Experimental Centrifugal Oil Cleaner Attached to Liberty Engine. Automotive Industries, vol. 43, no. 13, Sept. 23, 1920, pp. 610–611, 3 figs. Device designed and developed by Installation Branch, Power Plant Section, and constructed in shops at McCook Field.

GEARS

Bevel. Chordal Thickness of Tooth and Corrected Pitch Depth of Bevel Gears, C. W. Mapes. Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 169–170, 1 fig. Diagram showing dimensions and angles used in determining chordal thickness and corrected pitch depth of bevel gear teeth.

Calipers for. The "Sykes" Gear Tooth Caliper. Machy. (Lond.), vol. 16, no. 418, Sept. 30, 1920,



AS YOU WOULD EXPECT in a plant making such a high grade product, the Pierce-Arrow Motor Car Co. power house is a model one. Careful attention has been paid to the selection and installation of equipment in accord with the best and latest practice. Here six 600 HP boilers are fired by

RILEY UNDERFEED STOKERS

At this plant the Riley 2-Speed Gear Boxes have proved their worth when the load is suddenly reduced. A shift of the lever from high to low speed and the coal feed is cut in half while the prime mover continues to operate at an economical speed.

By this device the fire can be leveled, built up or thinned, as required. This results in fuel saving, for coke need not be carried over into the ash pit when building up thin sections.

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RILEY UNDERFEED STOKERS

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ENGINEERING INDEX (Continued)

pp. 8–4–805, 2 figs. Type of gear caliper that enables gear teeth to be gaged with one setting only.

Helical. Calculation of Helical Gears with Axes at Right Angles (Calcul des engrenages hélicoidaux à axes rectangulaires), Jean Bertrand. Vie Technique & Industrielle, vol. 1, no. 12, Sept. 1920, pp. 489–494, 8 figs. Formulæ and graphs for designing such gears.

Hobbing. Formulæ Used in Hobbing Large Prime Numbered Gears. A. Fisher. Machy. (Lond.), vol. 16, no. 415, Sept. 9, 1920, pp. 705–706. Formulæ used in calculations of change wheels for hobbing machines when cutting gears with large prime number of teeth.

Involute. Interference of Involute Spur-Gear Teeth, A. B. Cox. Am. Mach., vol. 53, no. 16, Oct. 14, 1920, pp. 707–708, 2 figs. Formula expressing relation between gear ratio, number of teeth in pinion and interference.

Testing, Machine for. Machines for Testing Gears (Machine à essayer les engrenages). Technique Automobile et Aérienne, vol. 10, no. 110, 1920, pp. 67–69, 7 figs. Mechanism for comparing gears with untoothed discs. (Concluded.)

GOLD MINES

Brazil. The Deepest Mine. Min. & Sci. Press, vol. 121, no. 14, Oct. 2, 1920, pp. 477–478, 1 fig. Morro Velho, a gold mine in Brazil, has reached depth of 6426 ft.

GRAIN ELEVATORS

Pneumatic. Pneumatic Elevators, William Cramp. Eng., vol. 110, no. 2853, Sept. 3, 1920, p. 330. Experiments to determine power required to lift granular material by pneumatic means. Empirical formula for vacuum in centimeters of mercury is developed in treatment of different pressures across conveying pipe and quantity of air per second moved under this pressure difference. (Abstract.) Paper read before Eng. Section, British Assn. for Advancement of Science.

GRINDING

Automobile Parts. Cadillac Grinding Practice, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 103–107, 9 figs. Description of methods employed in grinding department of plant building high-grade automobiles.

GRINDING MACHINES

Norton. Norton 10-inch "B" Type Grinding Machine. Am. Mach., vol. 53, no. 13, Sept. 23, 1920, pp. 604f–604g, 4 figs. Table speed has been increased to 36 ft. per minute, which is three times that of fastest speed hitherto attempted.

Spindles with Eccentric Motion. Grinding Machines with Spindles with Eccentric Motion (Schleifmaschinen mit Planetenspindel), W. Pockrandt. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 36, Sept. 4, 1920, pp. 713–716, 24 figs. Describes two new grinding machines for internal grinding of cylinders, bushings, etc., one of which has vertical and the other horizontal grinding spindles. Points out advantages and disadvantages of these two types.

Types. Two New Grinding Machines. Iron Age, vol. 106, no. 14, Sept. 30, 1920, pp. 858–859, 2 figs. Grinding speed increased 200 per cent on Norton Type B cylindrical grinder.

H

HANDLING MATERIALS

Mechanical Equipment for. Handling Materials Mechanically (La manutention mecanique des matières), M. Hegelbacher. Vie Technique & Industrielle, vol. 1, no. 12, Sept. 1920, pp. 495–498, 12 figs. Types of industrial conveyors. (Continuation of serial.)

HARBOR IMPROVEMENTS

Kingston Harbor. Proposed Development of Kingston Harbor, A. Langlois. Can. Engr., vol. 39, no. 15, Oct. 7, 1920, p. 408, 1 fig. Movement contemplates making Kingston the Lake Ontario terminal, for proper utilization of Welland Ship Canal.

HEAT PUMPS

Purpose of. The Heat Pump (Die Wärmepumpe), M. Hottinger. Schweizerische Bauzeitung, vol. 76, no. 10, Sept. 4, 1920, pp. 107–109, 7 figs. Describes device by use of which heat quantities which cannot be used because of their low temperature are brought to a higher and useful temperature, and gives costs of recovery of heat by this means.

HEAT TRANSMISSION

Thin Walls. Heating and Ventilating Research Work—V. Domestic Eng. (Lond.), vol. 40, no. 22, Oct. 1920, pp. 149–150. Heat transmission through thin walls. From report of Building Matls. Research Committee under British Department of Scientific and Industrial Research.

HEATING

Buildings, Losses in. Fundamental Principles of the Calculation of Heat Losses for Buildings (Grundlagen der Wärmeverlustberechnung für Gebäude), B. Biegeleisen. Gesundheits-Ingenieur, vol. 43, no. 31, July 31, 1920, pp. 361–372, 4 figs. Writer points out that, until other and more accurate tests are available, the most expedient way of improving method of calculation is (1) through determination of faults in existing methods, and (2) through utilization of results of tests carried out since the development of Rietschel's calculations. New method is evolved for calculation of heat transmission which, it is claimed, under certain conditions, may be more accurate than the Rietschel values.

Systems. Short Cuts to Accurate Calculations. Am. Architect, vol. 118, no. 2337, Oct. 6, 1920, pp. 450–452. Chart and table for computing steam radiation.

HEATING, ELECTRIC

Cooking Range. British Standard Specification for Electrically Heated Cooking Range (Two Sizes). British Eng. Standards Assn., no. 106, 1920, 15 pp., 6 figs. Specifications approved on July 8, 1920.

Developments in. New Heating and Cooking Apparatus. Elecn., vol. 85, no. 2210, Sept. 24, 1920, pp. 365–371, 24 figs. Survey of developments shows that electric heating and cooking continue to progress particularly in connection with large installations for restaurants, canteens, etc. It is also noted that electric heating and cooking is becoming increasingly popular for marine work, both cargo and passenger steamers and in Navy. Equipment survey is principally of British manufacture.

HEAVY-OIL ENGINES

Fuel Selection. The Selection of Fuel Oil for Heavy Oil Engines, Allen F. Brewer. Gas Engine, vol. 22, no. 10, Oct. 1920, pp. 295–297. It is advised that customer should approach market in selection of fuel oil from angle of presenting operating conditions and peculiarities of his plant, rather than limiting himself to laboratory specifications.

HELICOPTERS

See AEROPLANES, Helicopters.

HOISTS

Mine. Mine Hoist to Carry One Hundred Men. Power, vol. 52, no. 12, Sept. 21, 1920, pp. 456–457, 2 figs. Hoist, which is a single-drum motor-driven type is designed to operate in balance at rope speed of 800 ft. per minute.

Mine Safety Experts Discuss at Milwaukee Accidents, Health and Warfare—II, R. Dawson Hall. Coal Age, vol. 18, no. 16, Oct. 14, 1920, pp. 801–806. Safety devices on hoisting engines. Paper read before Nat. Safety Council.

Safety Brakes for. Increase of Safety against Falling and Increase of Efficiency in Hoists and Shaft Installations (Absturzsicherheit und Leistungserhöhung bei Aufzügen und Schachtanlagen), F. Jordan. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 34 and 35, Aug. 21 and 28, 1920, pp. 661–664 and 697–700, 9 figs. Discusses failures of safety brakes on hoists and hauling machines; unprofitableness of present high safety coefficient for rope and possibility of its reduction in mine practice; advantages of a braking device with compressed-air operation; arrangement and operation of the Jordan compressed-air brake; results of safety brake tests.

HOSE

Steam. Standard Specification for Steam Hose. Power, vol. 52, no. 15, Oct. 12, 1920, p. 601. Specifications adopted by Am. Soc. for Testing Matls.

HOUSES, CONCRETE

Concrete Blocks. Local Authorities and Housing. Surveyor, vol. 58, no. 1499, Oct. 8, 1920, pp. 235–236, 2 figs. Plan of constructing houses on continuous cavity system at Brighton.

HOUSING

Garden City Scheme, London. Unpopulating London, John Irwin Bright. Jl. Am. Inst. of Architects, vol. 8, no. 10, Oct. 1920, pp. 354–356, 2 figs. Housing scheme prepared by Garden Cities and Town Planning Assn., London. Instead of houses being packed together, it is proposed to create separate "Garden Cities" with population from 30,000 to 50,000, at convenient distances apart and ready for communication with center of metropolis.

Mining Towns. Kaska, a Mining Town in the Rebuilding. Coal Age, vol. 18, no. 15, Oct. 7, 1920, pp. 747–750, 12 figs. Each family has seven rooms and bath, furnace, radiators in every room, electric lighting and cemented cellar. All buildings of vitrified tile; some covered with stucco. Two large porches on every house.

Schemes. Big Scale Home Building by Motor Corporation. Automotive Manufacturer, vol. 42, no. 6, Sept. 1920, p. 11. Types of buildings constructed and material used in housing scheme worked out by General Motors Corporation at Flint, Mich.

Housing Development of the Viscose Company, Emile G. Perrot. Chem. Age (N. Y.), vol. 28, no. 9, Sept. 1920, pp. 324–326, 5 figs. Plan and details of industrial village.

HYDRAULIC TURBINES

Design. Design of the 37,500-Hp. Turbines at Niagara, George R. Shepard, Norman R. Gibson, Lewis F. Moody and W. M. White. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 646–653, 6 figs. Hydraulic features of 100,000-hp. addition to the hydroelectric power plants on American side of the Great Falls. Design of the two types of turbines.

Developments. Modern Developments of Hydraulic Turbine Design, Robert E. Horton. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, pp. 683–685. Precedent and principle as exemplified in new Niagara wheels. Minimum constraint a factor in efficiency.

HYDROELECTRIC PLANTS

California. New Hydroelectric Plant in Operation, Charles W. Geiger. Power Plant Eng., vol. 24, no. 19, Oct. 1, 1920, pp. 932–933, 2 figs. Kerckhoff hydroelectric project of San Joaquin Light and Power Corporation. Plant which has maximum capacity of 50,000 hp. was constructed at cost of over $5,000,000 and is said to be the only project of its kind begun, finally completed, and placed in operation since signing of armistice.

French Alps. Hydroelectric Installations of the Allevard Forges (Les installations hydroélectriques des forges d'Allevard), A. Garcin and J. Delestrade. Revue générale de l'Électricité, vol. 8, no. 12, Sept. 18, 1920, pp. 375–390, 35 figs. Installations for supplying energy to electric furnaces and light and power to Blast Furnaces and Forges of Allevard, in the French Alps.

Niagara Falls Development. Building the American Niagara Power Extension, O. D. Dales and G. W. Hewitt. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, pp. 694–701, 10 figs. Details of dredging, tunneling and erection operations on war-time 100,000-hp. addition to hydroelectric plant of Niagara Falls Power Co.

Developing an Additional 100,000 Horsepower at Niagara, John L. Harper, O. D. Dales and Louis S. Bernstein. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 582–588, 12 figs. Details of hydraulic and structural design and description of new water-power plant on American side of Falls.

Niagara Development Breaks Efficiency Records. Can. Engr., vol. 39, no. 12, Sept. 16, 1920, pp. 337–346, 14 figs. Symposium. New plant consists of three vertical units, each of 37,500 hp. maximum rating. Average overall efficiency of all three units, including all losses from forebay to switchboard, is 90 per cent when each generator is delivering approximately 24,000 kw.

Southern U. S. Power Development in the Southern States, George K. Miltenberger, Lyle A. Whitsit and Robert W. Lamar. Elec. World, vol. 76, no. 16, Oct. 16, 1920, pp. 769–771, 2 figs. Report of power section of war industries board reviews electric power resources of southern states at close of World's War and makes recommendations for efficient development to accommodate estimated demands of future.

I

ICE PLANTS

Raw-Water. World's Largest Raw-Water Plant. A. Crawford Craig. Refrigerating World, vol. 55, no. 10, Oct. 1920, pp. 14–18, 13 figs. Commonwealth Ice Company's West End Avenue Plant, New York, has capacity of eight hundred tons of ice per day. All machinery operated by direct connected motors.

IGNITION

Circuit Characteristics. Ignition Circuit Characteristics as Determined by Engine Requirements, Harry F. Geist. Automotive Industries, vol. 43, no. 14, Sept. 30, 1920, pp. 666–670, 7 figs. How proportions of primary circuit characteristics of battery and coil ignition system may be theoretically determined for production of spark of definite energy value for engine of any specified speed and number of cylinders.

Impulsive-Spark. The Ignition of Gases at Reduced Pressures by Impulsive Electric Sparks, W. M. Thornton. Lond., Edinburgh, and Dublin Philosophical Mag. and Jl. Sci., vol. 40, no. 237, Sept. 1920, pp. 345–356, 6 figs. Ignition by impulsive spark was found in experiments to be on the whole more difficult at low pressures than ignition by hot wires.

INDUCTANCE

Measurement of. Everyday Measurement of Inductance and Capacity in the Wireless Laboratory, L. B. Turner. Radio Rev., vol. 1, no. 12, Sept. 1920, pp. 585–590, 7 figs. Inductance and capacity bridges designed and constructed at Signals Experimental Establishment, Woolwich, England.

INDUSTRIAL MANAGEMENT

Inspection. Inspection: The Control of Quality —II, George S. Radford. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 290–294. Principles underlying permissible quality variations.

Office Management. Getting the Office Work Done—IV, Wallace Clark. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 267–270, 1 fig. Suggestions to office managers.

Operating Stores. Putting a Store in Your Factory, Leon I. Thomas. Factory, vol. 25, no. 6, Sept. 15, 1920, pp. 863–867, 14 figs. Based on experience of 125 plants.

Planning Department. The Planning Department. Eng. Production, vol. 1, no. 11, Oct. 1920, pp. 428–432, 15 figs. Its function, organization and personnel.

Production Systems. Keeping Production up with Sales, H. S. Hamilton. Factory, vol. 25, no. 6, Sept. 15, 1920, pp. 873–875, 3 fig. Individual production charts.

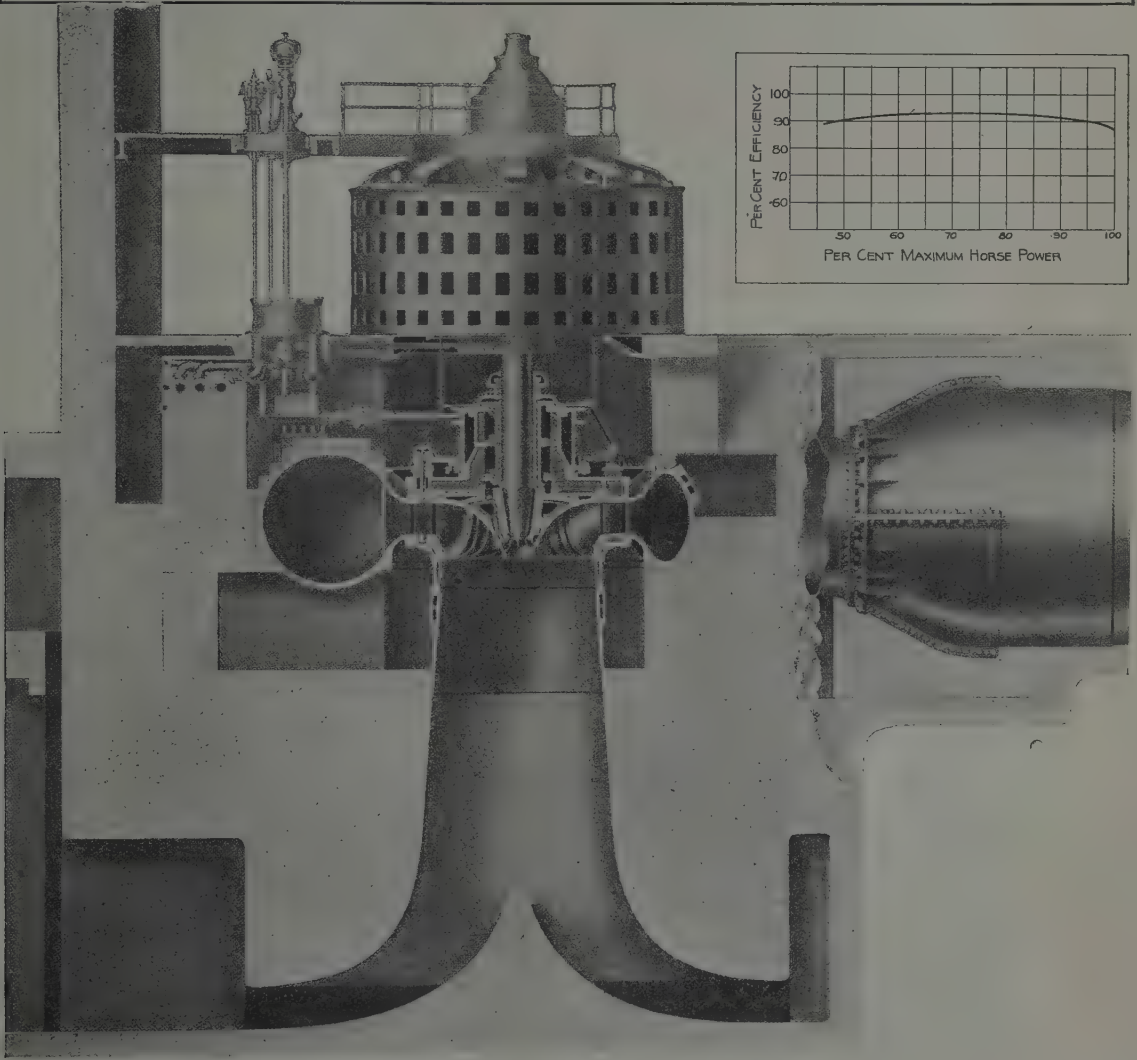
Modern Production Methods, W. R. Basset. Am. Mach., vol. 53, nos. 14 and 16, Sept. 30 and Oct. 14, 1920, pp. 619–625 and 709–711, 8 figs. Sept. 30: Discusses planning in shop where wide variety of articles is manufactured; Oct. 14: Utilizing cost system for increasing production.

The Importance of Planning in Production Work (Die Bedeutung der Vorbereitungsarbeiten derin Fertigung), Fritz Kopp. Betrieb, vol. 2,

I. P. Morris Hydraulic Turbines

The Wm. Cramp & Sons Ship & Engine Building Co.

Richmond and Norris Sts., Philadelphia



Two 37,500 Horse-Power Turbines built for the Hydraulic Plant of the Niagara Falls Power Co.

Some of the new features included with these turbines are: Spreading type of Draft Tube, Hydraulic Valve Control System for Governors, and Pneumatic Lubricating System.

The official test showed the remarkable results indicated above. An efficiency of over 90% was obtained from about 48% to 95% Maximum Power.

This company is now building Johnson Valves for the Larner-Johnson Valve & Engineering Company

ENGINEERING INDEX (Continued)

no. 11, June 1920, pp. 265–282, 60 figs. Discusses fundamental principles and shows how even a fabrication difficult with skilled labor can be carried out in this manner.

Routing Materials. Routing Considered as a Function of Up-to-date Management, H. K. Hathaway. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 278–286, 10 figs. Sets forth principles and purposes of routing, its history and elements of its technique. How to control flow of production by efficient routing of materials.

Shipbuilding. Production Methods in Shipbuilding—IV, William B. Ferguson. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 295–300, 6 figs. Cost keeping basis for production control.

Results Obtained by Applying Scientific Management in a French Ship Yard—II, M. Lavallee. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 287–289. Results in application of Taylor's principles to shipyard employing 3000 men at Chantier de Penhoet (Saint-Nazaire).

INDUSTRIAL RELATIONS

British Labor, Attitude of. The Attitude of British Labor toward Employers, J. R. Clynes. Automotive Industries, vol. 43, no. 15, Oct. 7 1920, pp. 730–731. Writer is member of parliament for labor party. Paper read before Industrial League and Council in England.

Collective Bargaining. Can Industrial Democracy be Efficient? The Rochester Plan, Meyer Jacobstein. Bul. of Taylor Soc., vol. 5, no. 4, Aug. 1920, pp. 153–159. Scheme of collective bargaining as operated by Clothier's Exchange of Rochester which comprises about 19 manufacturers in whose plants work 15,000 people.

Community Spirit. Community Spirit in Small Industrial Town, Edwin A. Hunger. Iron Age vol. 106, no. 17, Oct. 21, 1920, pp. 1038–1040, 5 figs. Development of one-big-family idea among employees by moving to village. Experience of Black & Decker Mfg. Co., maker of portable electric drills, automobile air compressors and valve grinders.

Developments. The Long March of Industrial Relations, Harry Tipper. Automotive Industries vol. 43 no. 15, Oct. 7, 1920, pp. 732–733. Reports, that three employees are to be elected to directorship of large industrial concern.

Kansas Industrial Court. The Kansas Industrial Court, K. H. Condit. Am. Mach., vol. 53, no. 17, Oct. 21, 1920, pp. 749–752. Account of its developments and description of its features.

Open-Shop Movement in U. S. How Seattle Fights Unfair Labor Unions. Iron Age, vol. 106, no. 17, Oct. 21, 1920, pp. 1055–1057. It is said associated industries have already accomplished much for open shop. Facts about radical movement last year.

Nation Swinging to Open Shop. A. J. Hain. Iron Trade Rev. vol. 67, no. 13, Sept. 23, 1920, pp. 846–852. Survey of activities in behalf of open shop in United States revealed in 240 cities of 44 states efforts are being made to promote "the American principle in employment relations." Included among these agencies are 23 national trade and industrial associations, many of which also have branch organizations in principal industrial cities.

The Open Shop a National Demand, Michael J. Hickey. Am. Industries, vol. 21, no. 3, Oct. 1920, pp. 26–28. It is reported that rotary clubs, chambers of commerce, hotel men's associations, bankers' associations, school organizations and fraternal organizations join in demand for industrial freedom all over the country.

INDUSTRIES

Japan. Industrial Prospects in Japan. Eng., vol. 110, no. 2854, Sept. 10, 1920, pp. 351. Development of Japanese industries during the war. From report on Commercial, Industrial and Financial Situation of Japan, 1914–1919, published by British Government.

INTERNAL-COMBUSTION ENGINES

Lubrication. The Lubrication of Internal-Combustion Engines (Zur Schmierung der Verbrennungskraftmaschinen), H. Praetorius. Motorwagen, vol. 23, no. 20, July 20, 1920, pp. 365–370, 12 figs. Description of a number of patented lubrication systems and devices of well-known German and Austrian firms.

Research. A High Speed Internal Combustion Engine for Research, H. R. Ricardo. Eng., vol. 110, nos. 2853 and 2854, Sept. 3 and Sept. 10, 1920, pp. 325–330 and 361–362, 13 figs. Sept. 3: Single cylinder unit of $4^1/_2$-in. bore and 8-in. stroke, fitted with special arrangements to provide for varying ratio of compression in shortest possible time while engine is running on full load, and design to run for long periods at piston speeds of from 2000 to 3000 ft. per min.; Sept. 10: Experiments of efficiency at reduced loads, with varying compression; effect of ignition and effect of inlet temperature. Paper read before Eng. Section, British Assn. for Advancement of Science.

Specific Heat of Working Fluid. Specific Heat and Dissociation in Internal-Combustion Engines, H. T. Tizard and D. R. Pye. Eng., vol. 110, no. 2853, Sept. 3, 1920, p. 325. Table giving dissociation of carbon dioxide and water at different temperatures and pressures. (Abstract.) Paper read before Eng. Section, British Assn. for Advancement of Science.

Valves. Accidents to Valves in Internal-Combustion Engines, and Steel to Use for these Valves (Pannes de soupapes et aciers à soupapes dans les moteurs à explosions), G. Gabriel. Technique Automobile et Aérienne, vol. 10, no. 110, 1920, pp. 69–82, 7 figs. Qualities which should be possessed by steel to withstand stresses to which valves are subjected are determined, steels being used for valve manufacture are surveyed, and suggestions are given as to more systematic selection of such steels.

[See also GAS ENGINES; GASOLINE ENGINES; HEAVY-OIL ENGINES; OIL ENGINES SEMI-DIESEL ENGINES.]

IRON AND STEEL

Japanese Industry. Japanese Development in Iron and Steel. Iron Age, vol. 106, no. 17, Oct. 21, 1920, pp. 1045–1047. Actual production limited, but exploitation of prospects is active. Large government advances to private steel corporations.

Production in U. S. Decreased Production of Iron and Steel. Iron Age, vol. 106, no. 15, Oct. 7, 1920, pp. 925 and 955. Statistics for 1919 compiled by Am. Iron & Steel Inst. Effect of steel strike and other unfavorable conditions is shown, but gains were made in output of number of products.

Production of Steel Ingots and Castings, Finished Forms of Rolled Iron and Steel, and Miscellaneous Iron and Steel Products in the United States in 1919. Special Statistical Bul. no. 4, 1920 of Am. Iron & Steel Inst., Sept. 25, 1920, 4 pp.

IRON-CARBON ALLOYS

Graphitization. On Graphitization of Iron-Carbon Alloys, Kōtarō Honda and Takejirō Murakami. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 7, 8 pp. Results of experiments established that in pure iron-carbon alloys, graphitization is caused by decomposition of cementite solidified during cooling from melt. It is held that graphitization is not direct decomposition of cementite at high temperature but is caused by catalytic action of carbon monoxide or dioxide.

IRON METALLURGY

India. Indian Iron Making at Mirjati, Chota Nagpur, Andrew McWilliam. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 10 9 pp. Ore used is brown hæmatite. Charcoal is used as fuel but no material is added as flux.

IRON-NICKEL ALLOYS

See NICKEL-IRON ALLOYS.

IRRIGATION

Current Motor for. An Automatic Current Motor. Engr., vol. 130, no. 3378, Sept. 24, 1920, p. 308, 2 figs. Device for utilizing force of stream for lifting water from it primarily for irrigation purposes, patented by F. L. Gilman, of Los Angeles, Cal.

K

KEYS

Standardization of. Measurement of the Thickness of Keys (Keilhöhenmessung), Kurt Hentschel. Betrieb, vol. 2, no. 13, July 1920, pp. 358–359, 11 figs. By comparison of advantages and disadvantages of measurements at thick end, thin end and in the middle, it is shown that measurement at thin end is the only feasible one for standardization.

L

LABOR

Europe. Europe's Labor is in a Ferment, H. Cole Estep. Iron Trade Rev., vol. 67, no. 15, Oct. 7, 1920, pp. 995–997. Conditions in Europe are termed "ripened fruits of the closed shop policy." It is said Italy is steeped in industrial anarchy and England is like a bomb ready to burst.

Shortage in Construction Industry. Immigration and the Construction Industry. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 642–643. Labor shortage not yet relieved by growing number of immigrants who are mostly women and children. Prohibition said to be no deterrent.

LABORATORIES

Aerodynamic, Italy. Aerodynamic Laboratory of the Royal Polytechnic Institute of Turin (Il laboratorie di ærodinamica del R. politecnico di Torino), M. Panetti. Associazione Nazionale degli Ingegneri Italiani, vol. 1, no. 6, Feb. 29, 1920, pp. 35–36, 1 fig. Description of equipment. (Concluded.)

Lausanne University. Electrical Laboratory at the Engineering School of Lausanne University (Le laboratoire d'électricité de l'école d'ingenieurs de l'université de Lausanne), J. Quinet. Electricien, vol. 51, nos. 1259 and 1260, Sept. 1 and 15, 1920, pp. 361–366 and 385–391, 18 figs. Details of installation of machinery and equipment.

New York Chemical Works. New Laboratory of the Newport Company, George E. Bird. Chem. Age (N. Y.), vol. 28, no. 9, Sept. 1920, p. 339, 2 figs. Plan of building laboratory and conveniences for research work.

Photographic Research. A Photographic Research Laboratory, C. E. Kenneth Mees. Jl. Royal Soc. of Arts, vol. 68, no. 3539, Sept. 17, 1920, pp. 695–703 and (discussion) pp. 703–705, 4 figs. Survey of work done at research laboratory of Eastman Kodak Co.

Textile Research. Textile Research Laboratory, Herbert T. Wade. Sci. Am. Monthly, vol. 2, no. 2, Oct. 1920, pp. 153–157, 8 figs. Miniature textile mill of Nat. Bur. of Standards.

LADLES

Lifters for. Fractures in Ladle Lifters (Brüche an Giesspfannengehängen), A. Pomp. Stahl u. Eisen, vol. 40, no. 34, Aug. 26, 1920, pp. 1136–1138, 3 figs. Results of investigations show that fracture of a ladle lifter is due to changes in form of material at blue heat.

LATHES

Turret. Alfred Herbert No. 5 Automatic Turret Lathe. Am. Mach., vol. 53, no. 13, Sept. 23, 1920, pp. 600–601, 1 fig. General-purpose automatic machines representative of English practice. Comparison with American automatic turret lathes.

[See also AUTOMOBILES, Clutches, Machining.]

LIGHT

Transmission through Atmosphere. Relative Spectral Transmission of the Atmosphere, Enoch Karrer and E. P. T. Tyndall. Dept. of Commerce, Sci. Papers of Bur. of Standards, no. 389, July 21, 1920, pp. 377–408, 20 figs. Transmission of atmosphere was studied with a view to determining data useful for ærial photography and use of light projectors for automobile and locomotive headlamps, for signaling and as beacons, and for searching on land, water and in the air.

LIGHTING

Arc vs. Incandescent Lamps. Comparative Cost of Lighting by Arc and by Incandescent Lamps (Coût comparatif de l'éclairage par arc et par incandescence), M.-H. Dupont. Bulletin mensuel de la Société belge des Électriciens, vol. 34, no. 4, Aug. 1920, pp. 157–172. Total cost, including installation and maintenance, is determined to be smaller for incandescent lamps. Installations considered are principally those in industrial works.

Candlepower Required. Relation of Lighting Feeders to Watts per Square Foot, Victor Tousley. Elec. World, vol. 76, no. 14, Oct. 2, 1920, pp. 686–687. Tables showing actual demand factors in units per square foot used in different classes of business and industry.

Design of System. Designing Direct and Indirect Illumination, M. M. Samuels and C. O. von Dannenberg. Elec. World, vol. 76, no. 15, Oct. 9, 1920, pp. 721–724, 9 figs. Practical method of determining illumination in given plane for either direct or indirect fixtures and original scheme of calculating foot-candle in one horizontal plane from values obtained in another.

Factory. Shop Lighting, C. W. Price. Bul. Dept. of Labor & Industry, vol. 7, no. 4, 1920, pp. 39–44. Suggested standardization.

Theaters. Lighting the World's Largest Theater. Elec. World, vol. 76, no. 16, Oct. 16, 1920, pp. 776–779, 9 figs. Electric fixtures used for lighting Capitol Theater, New York City, which has seating capacity of 5300.

LOCOMOTIVE BOILERS

Copper vs. Steel Tubes. Locomotive Boiler Tubes: Copper vs. Steel, Gerard A. Muntz. Ry. Gaz., vol. 32, no. 26, June 25, 1920, pp. 943–944. Comparative economy in use of copper, brass and steel tubes in locomotive boilers. Further notes on discussion given in issue of June 4, Ry. Gaz.

Water-Level Indicators. Correct Application of Water-Level Indicators in Locomotive Boilers, A. G. Pack. Boiler Maker, vol. 20, no. 9, Sept. 1920, pp. 261–265, 5 figs. Investigations conducted by Bur. of Locomotive Inspection, Interstate Commerce Commission, to determine effect of water circulation on accuracy of indicating devices.

Government Test of Water-Indicating Devices, A. G. Pack. Ry. Mech. Engr., vol. 94, nos. 9 and 10, Sept. and Oct. 1920, pp. 575–579 and 630–633, 7 figs. Sept.: Account of tests conducted by Bureau of Locomotive Inspection. Tests demonstrated unreliability of many water-indicating appliances on modern locomotives; Oct.: Report of final tests and recommendations submitted by Bureau of Locomotive Inspection.

LOCOMOTIVES

Development in U. S. The Development of the Modern Steam Locomotive in the United States, Fredk. V. Green and John D. Rogers. Jl. South African Instn. Engrs., vol. 19, no. 2, Sept. 1920, pp. 14–22 and (discussion) pp. 22–29, 2 figs.

Diesel-Electric. Diesel-Electric Locomotives on Railways (Diesel-elektriske Motorvogner for Jernbanedrift), E. Hubendick. Teknisk Ukeblad, vol. 67, nos. 28 and 29, July 9 and 16, 1920, pp. 374–377 and 385–388, 13 figs. New type of railway motor car introduced on secondary lines in Sweden. Car weighs 29.3 tons and motive power is supplied by 75-hp. four-cycle Diesel oil engine having six cylinders and running at speed of 550 r.p.m.

Feedwater Heaters. Locomotive Feedwater heating in Europe, Robert E. Thayer. Ry. Mech. Engr., vol. 94, no. 9, Sept. 1920, pp. 569–574, 8 figs. There are over 10,000 feedwater heaters in use on railways of Europe. These are distributed among Weir system, Caille-Potonie system and Knorr system, the latter having by far the greater distribution. Weir system is confined almost entirely to Great Britain, Caille-Potonie to France, and Knorr to Germany, Holland and Switzerland.

Freight. New Mountain Type Locomotives for Fast Freight. Ry. Age, vol. 69, no. 15, Oct. 8, 1920, pp. 608–611, 7 figs. Dimensions: Tractive effort, 53,900 tons; weight of engine and tender in working order, 511,000 tons; wheel base, total, 40 ft.; total heating surface, 4121 sq. ft.; superheater heating surface, 1009 sq. ft.; working pressure, 200 lb. per sq. in.

Number Seven
of a Series

Working Points

(Not Talking Points or Selling Points)

of the Hartness Flat Turret Lathe

The Flat Turret—I

The invention of the Flat Turret marked the point where the "screw machine" ceased to be a screw machine and became a Turret Lathe.

It made possible a turret lathe which would do every kind of lathe work within its range—shafts, pulleys, bushings, gear blanks bolts—any old thing.

Why?—*For a number of reasons.*

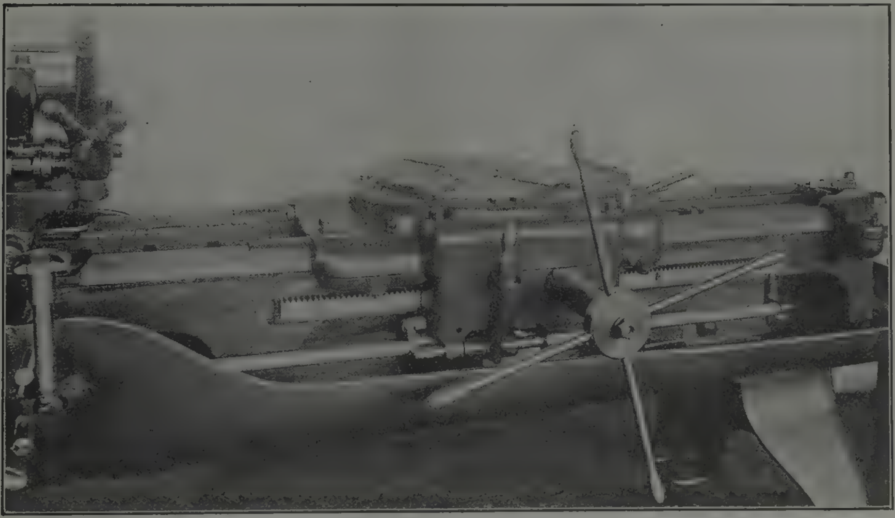
In the first place, it provided for the first time a tool support rigid enough to carry real cutting tools which could take real chips.

Observe in the illustration how low the turret is, and how closely it hugs the V's of the lathe bed.

Notice also that it is gibbed clear around the circumference.

The old turret was a lofty structure with a narrow base held down by a central bolt.

This is only a part of the story.



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SEE OUR DATA IN 1920 A S M E CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

ENGINEERING INDEX (Continued)

Oil Firing. Heavy-Oil Firing for Locomotives, L. Pierre-Guedon. Bul. Int. Ry. Assn., vol. 2, no. 8, Aug. 1920, pp. 517–527, 10 figs. Historical summary, with special reference to developments in design of locomotives for burning oil, as worked out by Paris-Lyons-Mediterranean Ry. Translated from Génie Civil.

The Scarab System of Oil Fuel Burning on Locomotives. Eng., vol. 110, no. 2853, Sept. 3, 1920, pp. 324, 3 figs. System as applied in locomotive of London and Northwestern Railway. System was introduced by Scarab Oil Burning Co., Ltd., Haymarket, England.

Rebuilding. Rebuilding Locomotives at Kilmarnock Works, Glasgow & South Western Railway. Ry. Gaz., vol. 33, no. 13, Sept. 24, 1920, pp. 396–399, 7 figs. Reconstruction work involves putting boiler 6 in. larger in diameter, and making steam reversing gear direct instead of being actuated through rocking lever and link, as formerly.

Superheater. Efficiency of Clench Superheater (Alcune prove per valutare la efficienza ed il rendimento del surriscaldatore sistems Clench), Alessandro Mascini. Rivista tecnica delle Ferrovie italiane, vol. 18, no. 2, Aug. 15, 1920, pp. 48–55, 2 figs. Records of service of locomotives with Clench superheaters operated by Italian State Railways.

A Convenient Method of Recording Performance of Superheated Steam Locomotives for Traction Service, Especially for the Planning of Schedules (Ueber eine zweckmässige Darstellungsart von Leistungen der Heissdampflokomotiven zur Verwendung im Zugförderungsdienst, besonders auch bei Aufstellung von Fahrplänen, erläutert an praktischen Beispielen), H. Velte. Annalen für Gewerbe u. Bauwesen, vol. 87, nos. 1 and 2, July 1 and 15, 1920, pp. 2–7 and 9–14, 7 figs. Practical examples are cited. (To be continued.)

Tank. New Tank Locomotives, Belfast and County Down Railway. Ry. Gaz., vol. 33, no 13, Sept. 24, 1920, pp. 408, 1 fig. Characteristics: Wheelbase, 4–6–4; boiler pressure, 170 lb. per sq. in; cylinders, 26 in. stroke by 5 ft. 6 in. diameter; tractive force, 18,130 lb. at 75 per cent boiler pressure; total heating surface, 1621.7 sq. ft.; combined capacity of side and bunker tanks, 2000 gal. of water; accommodation is provided for 4 tons of coal.

[See also ELECTRIC LOCOMOTIVES.]

LUBRICATING OILS

Castor vs. Mineral Oil. A Comparison of Qualities of Castor and Mineral Oils, Fred C. Ziesenheim. Automotive Industries, vol. 43, no. 13, Sept. 23, 1920, pp. 612–613, 1 fig. Results of tests. Superiority of castor oil over mineral oils for particular conditions of service is due primarily to its greater capillarity which results from presence of free fatty acids.

Specifications. Development of Oil Specifications, William F. Parish. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 313–315. Points to be considered in drawing up specifications, with reference to specifications for lubricating oils used by War Department.

LUBRICATION

Capillarity and, The Nature of Capillarity and its Relations to the Lubricating Quality of Oils and to the Lubrication of Metals (Das Wesen der Kapillarität, ihre Beziehungen zur Schmierergiebigkeit der Schmieröle und zur Schmierfähigkeit der Metalle). Petroleum, vol. 16, nos. 8 and 9, July 10 and 20, 920, pp. 249–254 and 285–291, 25 figs. Claims that the lubricating power of oil can be directly calculated and that it is influenced by the lubricating metal itself.

M

MACHINE TOOLS

Counterweights for. Machine Tool Counterweights, Fred Horner. Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 108–114, 17 figs Methods of applying counterweights to different types of machine tools for counterbalancing weights of spindles, slides and work-tables.

International Exhibition. Machine Tools at Olympia. Eng. Production, vol. 1, nos. 10 and 11, Sept. 18 and Oct. 1920, pp. 364–398 and 409–427, 139 figs. Sept. 18: Detailed descriptions of leading exhibits; Oct.: Review of exhibits of small tools and workshop accessories. An appendix is included in which progress in machine tool industry is surveyed. Résumé of salient features as evidenced at Olympia exhibition.

The Machine Tool Exhibition. Engr., vol. 130, nos. 3375–3378, Sept. 3, 10, 17 and 24, pp. 228 and 232–235, 224–248 and 254, 269–272, and 291–296 and 302, 95 figs. Details of exhibits.

The Machine Tool and Engineering Exhibition at Olympia. Eng., vol. 110, nos. 2853–2856, Sept. 3, 10, 17 and 24, 1920, pp. 301–309, 333–341, 363–372, and 397–403, 194 figs., partly on 28 supp. plates. Detailed description of exhibits.

The Second International Machine Tool and Engineering Exhibition. Machy. (Lond.), vol. 16, nos. 415–418, Sept. 9, 16, 23 and 30, 1920, pp. 720–729, 751–755, 781–791, and 816–824, 52 figs. Review of principal exhibits, with special reference to new designs.

Paris Exhibition. Machine Tools at the Paris Exhibition (Les machines-outils et l'outillage méchanique à la foire de Paris), Ouvrier Moderne, vol. 3, nos. 3, 4 and 5, June, July and Aug. 1920, pp. 111–112, 159–160 and 206–208, 10 figs. Details of principal exhibits shown at Paris exhibition held May 5–20, 1920.

Special-Purpose. Special-Purpose Machines in the LeBlond Plant. Machy. (Lond.), vol. 16, no. 418, Sept. 30, 1920, pp. 797–803, 7 figs. Also Machy. (N. Y.), vol. 27, no. 2, Oct. 1920, pp. 144–150, 7 figs. Vertical sawing machine built for operation customarily performed on radial drilling machines, special keyseater for long shafts, planer adapted for grinding large flat surfaces, etc.

MACHINERY

Foundations, Vibration of. The Distant Transmission of Foundation Vibration in the Operation of Engines with Reciprocating Masses (Die Fernübertragung von Bodenerschütterungen bei Maschinen mit hin- und hergehenden Massen), H. Gerb. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 38, Sept. 18, 1920, pp. 759–760, 2 figs. Is said to occur only in the case of plastic subsoil, in which the vibrations are propagated as surface waves. "Vibration dampers" are suggested as remedy for small engines, and thorough balancing of the reciprocating masses for large engines.

Shipment of. Insuring the Safe Shipment of Machinery, Fred H. Colvin. Am. Mach., vol. 53, no. 16, Oct. 14, 1920, pp. 712–718, 17 figs. Methods of development by Brown & Sharpe Mfg. Co., Providence, R. I.

MALLEABLE IRON

Annealing Ovens. New Oven Secures Uniform Anneal. Foundry, vol. 48, no. 19, Oct. 1, 1920, pp. 768–771, 11 figs. Two fireboxes at each side are in oven proper. Flues are located in center of floor. Four tons of castings are annealed with one ton of coal.

MANGANESE ORE

Smelting, Electric. Electric Furnace Smelting of Montana Manganese Ores, E. S. Bardwell. Gen. Meeting of Am. Electrochem. Soc., Sept. 30–Oct. 2, 1920, paper no. 14, pp. 137–152. Account of plant of Onaconda Copper Co. at Great Falls, Mont. for reducing Montana rhodochrosite manganese ores. Detailed description is given of furnace, electrode holders, and operation of furnaces.

MARINE BOILERS

See BOILERS, WATER-TUBE, Houghton's Patent.

MARINE ENGINES

See OIL ENGINES.

MARINE STEAM TURBINES

Emergency Governor. Emergency Governor and Gear for Marine Turbine. Eng., vol. 110, no. 2854, Sept. 10, 1920, pp. 344–345, 8 figs. Type being introduced by Messrs. Aspinall's Patent Governor Co., Liverpool.

Flexible Expansion Coupling. The "Robertson-Fairfield" Flexible Expansion Coupling. Eng., vol. 110, no. 2854, Sept. 10, 1920, p. 357, 5 figs. Coupling consists of casing or shell made in halves which are bolted together when coupling is assembled. "Pivot keys sockets" fitted in slots machined in casing, transmit drive to casing. Any relative axial motion between drivers and driving shaft is provided for by sliding these blocks along their slots in shell.

Rateau. The Development of the Rateau Geared Turbine for Marine Work, A. V. Jarratt. Elecn., vol. 85, no. 2207, Sept. 3, 1920, pp. 253–257, 6 figs. Rateau turbines as manufactured by Metropolitan-Vickers Electrical Co., Ltd. Turbine is constructed with two cylinders, high and low pressure, mounted side by side, both driving high-speed pinions on reduction gearings.

MATERIALS

Testing. Compares Fatigue and Recovery, Robert G. Guthrie. Iron Trade Rev., vol. 67, no. 13, Sept. 23, 1920, pp. 843–845, 4 figs. Instruments for determining recoverance, which is capacity of material to return immediately energy that has been imparted to it by any external force. Records of operation of machine.

Recoverance, Robert G. Guthrie. Chem. and Metallurgical Eng., vol. 23, no. 14, Oct. 6, 1920, pp. 671–672. Recoverance is defined as capacity of material to return immediately energy that has been imparted to it by any external forces. Methods of measuring recoverance are explained.

MEASURING INSTRUMENTS

Two-Needle. New Type of Apparatus for the Direct Measurement of Magnitudes which are Functions of Two Variables (Sur une nouvelle classe d'appareils de mesure pour l'evaluation directe des grandeurs fonctions de deux variables), L. Barbillion and M. Dugit. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 7, Aug. 17, 1920, pp. 389–392. Instruments using two needles, one curvilinear and one rectilinear, or both curvilinear, turning about the same axis. As exampled are quoted an instrument for measuring relative velocity of an aeroplane, and an indicator of carburation in explosion motors.

Simple Harmonic Analyzer. A Simple Harmonic Analyzer, V. Bush. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 10, Oct. 1920, pp. 903–905, 4 figs. Mechanical integrator.

METALLURGY

Control of Products. Recent Progress in Methods of Controlling Metallurgical Products (Les progrès récents des méthodes de controle des produits métallurgiques), Léon Guillet. Génie Civil, vol. 77, nos. 11 and 12, Sept. 11 and 18, 1920, pp. 214–218 and 232–236, 51 figs. partly on supp. plate. Physico-chemical analyses, and micrographic and macrographic studies. Properties and uses of equilibrium diagrams. (Continuation of serial.)

Methods of Control. Recent Progress in Methods of Controlling Metallurgical Products (Les progrès récents des méthodes de controle des produits métallurgiques), Léon Guillet. Génie Civil, vol. 77, no. 10, Sept. 4, 1920, pp. 185–190, 5 figs. Method of testing. (Continuation of serial.)

Progress in. Recent Progress in Methods of Controlling Metallurgical Products (Les progrès récents des méthodes de controle des produits métallurgiques), Léon Guillet. Génie Civil, vol. 77, no. 9, Aug. 28, 1920, pp. 172–178, 6 figs. Schemes for analysis of metallurgical products by electrolysis. (To be continued.)

Standardization in. Rulings of the Permanent Commissions of Standardization in Regard to Metallurgical Product (La commission permanente de standardisation ses décisions au point de vue des matériaux métallurgiques), Léon Guillet. Revue de Métallurgie, vol. 17, no. 6, June 1920, pp. 408–420, 5 figs. Rulings in regard to testing machines, methods of testing and nature of tests to be made of metallurgical products, especially steel.

METALS

Compressive Strength of. Resistances of Metals and Alloys to Compression (Widerstand von Metallen und Legierungen gegen Druck), A. Pomp. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 37, Sept. 11, 1920, pp. 745–746, 1 fig. Results of investigation of lead, lead and tin alloy, copper, brass, aluminum, low carbon steel, and steel with 5 per cent carbon, are given in tabular form and in curves.

Crystal Growth and Recrystallization. Crystal Growth and Recrystallization in Metals. H. C. H. Carpenter and Miss C. F. Elam. Eng., vol. 110, nos. 2855 and 2856, Sept. 17 and 24, 1920, pp. 385–389 and 424–426, 38 figs. Sept. 17: Results obtained in experiments with cold-rolled aluminum sheets and with an alloy of tin and antimony containing 1.5 per cent antimony, are studied in light of theories explaining crystal growth and recrystallization. It is shown how these results deprecate such theories. Modifications as to theories are suggested. Sept. 24: Among facts observed are that growth may take place either of large crystal into smaller one, or of small into larger, that relative orientation of crystal which is being grown into and that which is growing does not appear to affect growth, and that rate of growth is not constant for any given time at any particular temperature. (Abstract.) Paper read before Inst. of Metals.

Rupture of. Theory of Plasticity and Rupture of Isotropic Solids (Théorie de la plasticité et de la fragilité des solides isotropes), Marcel Brillouin. Annales de Physique, vol. 13, May-June 1920, pp. 217–235, 1 fig. Discusses formulating law, of rupture of metals.

Solution in Acids. The Solution of Metals in Acids as Related to Corrosion, William D. Richardson. Gen. Meeting of Am. Electrochem. Soc., Sept. 30–Oct. 2, 1920, paper no. 15, pp. 153–186. In consistent behavior of metals in corrosion and acid solution phenomena is explained by taking into consideration number of factors, as solution tension, influence of hydrogen, oxygen, carbon dioxide, cathode and halogen.

Thermoelectric Power. Thermoelectric Power of Pure Metals (Sur le pouvoir thermoélectrique des métaux purs), H. Pelabon. Annales de Physique, vol. 13, May-June 1920, pp. 169–187, 15 figs. Results of experiments. Graphs are given showing temperature against thermoelectric power for combinations of platinum and each one of several other metals. Thermoelectric power was found to vary continuously with temperature.

METEOROLOGY

High Altitudes. Meterological Characteristics of Atmosphere at High Altitudes (Les caractères météorologiques de la haute atmosphère), J. Rouch. Aérophile, vol. 28, nos. 13–14, July 1–15, 1920, pp. 210–217, 3 figs. Survey of researches. Compilation of data obtained.

METRIC SYSTEM

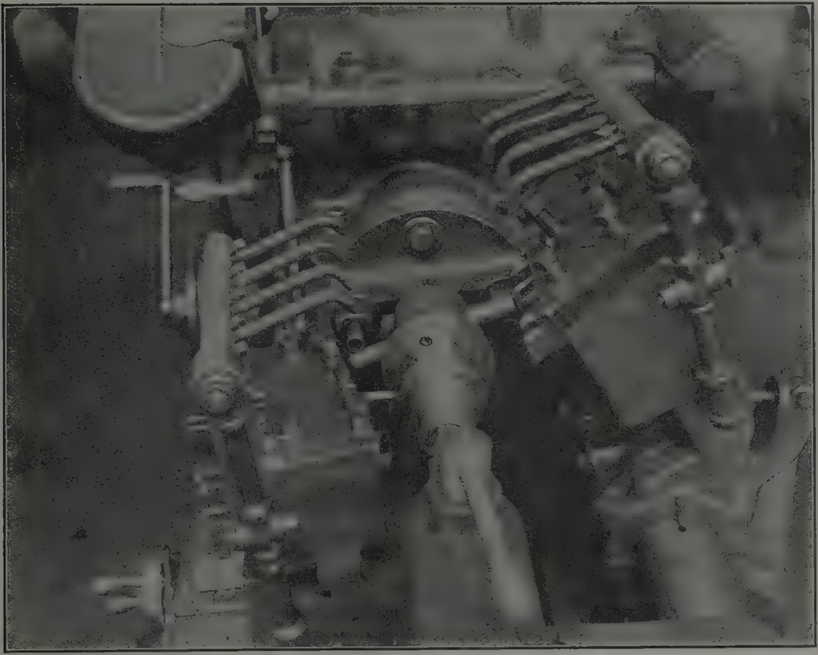
Arguments Against Adoption in U. S. Committee on Technical Standards, Bureau of Surveys and Maps, Recommends Use of English Measuring System. Am. Mach., vol. 53, no. 14, Sept. 30, 1920, pp. 647–648. Stand taken by Committee in regard to question as to whether maps should be published on standard scales of metric or English measurement. It is stated that "to make a metric law compulsory would be a great misfortune to the country."

The International Chamber of Commerce did not Indorse the Metric System, Ethan Viall. Am. Mach., vol. 53, no. 16, Oct. 14, 1920, p. 735. It is said that a resolution advising that United States and British Empire "standardize on the metric system solely" was introduced, discussed and definitely turned down.

What the Steel Industry Thinks of the Compulsory Metric System, Ethan Viall. Am. Mach., vol. 53, no. 14, Sept. 30, 1920, p. 643. Replies received to questionaire sent out to members of Assn. of Am. Steel Manufacturers asking them for their attitude with regard to adoption of metric system in United States. 96.3 per cent of members are against compulsory use of metric system, 0.5 per cent were neutral, 0.7 per cent were in favor and 2.5 per cent expressed no preference.

FAY AUTOMATIC LATHE

Cluster Gears for Automobile Transmissions



The above photograph shows a three-step cluster gear, machined from a forging with a large amount of stock to remove.

The forging has been chucked and had the large end faced in the turret lathe, the hub at the other end being squared up by a counterbore in the drill press.

A hole is drilled in the finished face to carry a driving pin, made necessary by the heavy cuts.

Three arbors and two machines are used, roughing in one machine and finishing in the other, and changing work on the third arbor while the others are in use.

This is a very successful set-up used, with modifications, by a number of different shops. No faster or more accurate has yet been discovered for this work.

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ENGINEERING INDEX (Continued)

Arguments in Favor of. 100,000 Petitions for Metric System. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 10, Oct. 1920, p. 889. It is reported that the Dept. of Commerce at Washington, D. C., has received over 100,000 petitions from all over the United States urging upon Congress the adoption of metric system of weights and measures as exclusive legal standard.

Great Britain. Metric Committee's Report. Chem. Trade Jl. and Chem. Engr., vol. 67, no. 1738, Sept. 11, 1920, p. 351. Notice regarding report of Committee appointed by Conjoint Board of scientific societies "to consider the proposed compulsory adoption of the metric system in the United Kingdom." They recommend that British system of units of weights and measures be retained. In preference to any alteration of present system they "would recommend the whole-hearted adoption of the metric system."

Units, New. New Units in the Metric System—Legally Adopted in France. Sci. Am. Monthly, vol. 2, no. 2, Oct. 1920, p. 152. Names adopted for units in centimeter-gram-second system. One is, for example, stheme, unit of force, which in one second of time communicates to mass equal to one ton, an increase of velocity of one meter per second. Translated from Jl. Officiel.

MICROMETERS

Manufacture. Making the Almond Micrometer, Ethan Viall. Am. Mach., vol. 53, no. 14, Sept. 30, 1920, pp. 605–611, 28 figs. Manufacturing methods of T. R. Almond Manufacturing Co., Ashburnham, Mass.

MILLING

Elliptical Shapes. Fixture for Milling an Ellipse, P. A. Fredericks. Am. Mach., vol. 53, no. 17, Oct. 21, 1920, pp. 752–754, 4 figs. Fixture devised for milling small elliptical shapes on production basis.

MILLING MACHINES

Continuous. Continuous Milling Machine with Fixed Production. Automotive Industries, vol. 43, no. 14, Sept. 30, 1920, pp. 664–665, 5 figs. Machine equipped with revolving work table, which is adjustable on base, in order that work may be placed upon smallest possible radius and cutter of smallest possible diameter utilized.

Thread. Thread Milling Machines (Gewindefräsmaschinen), Philipp Kelle. Der praktische Maschinen-Konstrukteur, vol. 53, no. 26, July 1, 1920, pp. 113–118, 12 figs. Enumerates advantages of thread milling over thread cutting on the lathe, and gives details and operation of horizontal thread milling machines employing side-milling cutter.

MINE HOISTING

Electric. Typical Installations of Electric Mine Hoisting in South Africa, E. B. Hell. Gen. Elec. Rev., vol. 23, no. 9, Sept. 1920, pp. 775–782, 7 figs. Description of mines, shafts, hoists, electrical equipment, and control devices of latest and largest installations of electric mine hoists both of direct-current motor and induction motor types.

MINE-RESCUE WORK

Rescue Car. Nova Scotia Co.'s Rescue Car: First Firm in America to Use Breathing Apparatus, Frank H. Kneeland. Coal Age, vol. 18, no. 15, Oct. 7, 1920, pp. 728–730, 3 figs. Car for fourteen men, heated by electricity or steam, carries five sets of apparatus, maps of mines and of water lines, and first-aid room.

MINERS' LAMPS

Research. Miners' Lamps Committee. Iron & Coal Trades Rev., vol. 101, no. 2742, Sept. 17, 1920, pp. 365–368, 9 figs. Committee was appointed by British Home Secretary to inquire and report what improvements were possible in miners' lamps as regards safety and illumination and what alterations were desirable in present methods of testing and approving such lamps. Article gives report issued by research sub-committee on passage of flame of an explosion through wire gauze.

MINING INDUSTRY

Prussia. Experiments and Improvements in the Mining Industry in Prussia during 1919 (Versuche und Verbesserungen beim Bergwerksbetriebe in Preussen während des Jahres 1919). Zeitschrift für das Berg-, Hütten u. Salinenwesen, vol. 68, no. 1, 1920, pp. 1–17, 21 figs. Deals with improvements in mining; haulage and conveying; mine illumination, breathing apparatus, etc.; steam boiler and engine practice; preparation of cokes, briquetting etc.

Welfare Work. McDowell County, Coal Mining Being Almost Sole Industry, Provides Free Dentistry. Coal Age, vol. 18, no. 15, Oct. 7, 1920, pp. 743–744. Thirteen dentists and as many hygienists visit schools three times a year and take care of children's teeth, recording condition and health of little patients.

MOLDING METHODS

Large Gas Main. Casting Pipe Specials in Green Sand. Engr., vol. 130, no. 3375, Sept. 3, 1920, p. 226, 4 figs. Procedure employed in casting large branch piece for gas main.

MOTION

Curvilinear. Motion of a Point Subjected to a Constant Central Acceleration (Mouvement d'un point matériel soumis à une accélération centrale attractive constante), Luc Denis. Vie Technique & Industrielle, vol. 1, no. 12, Sept. 1920, pp. 498–500, 3 figs. Equation of motion of particle rotating within conical vessel, and subjected, therefore, to component of gravity along edge of conical surface.

MOTOR BUSES

Electric-Railway, Use of. Motor Buses as Railway Auxiliaries. Elec. Ry. Jl., vol. 56, no. 15, Oct. 9, 1920, pp. 707–709. Statistics of operation of motor buses by electric railway company.

Metal-Framed. Metal-Framed Motor Omnibus Body. Eng., vol. 110, no. 2856, Sept. 24, 1920, pp. 406–408, 14 figs. Development from steel construction for aircraft. Constructed by Aircraft Steel Construction Co., Engineers, London, England.

MOTOR PLOWS

German Types. The Latest Types of German Motor Plows (Deutsche Motorpflüge in ihrer neuesten Bauart), H. Poland. Allgemeine Automobil-Zeitung, vol. 21, nos. 21–22, 23 and 24, May 22, June 5 and 12, 1920, pp. 30–34, 25–28 and 17–20, 28 figs. Describes various new counstructions which, it is claimed, are not only the cheapest on the world market under present conditions of exchange, but also surpass all foreign constructions in regard to quality of workmanship.

MOTOR TRUCKS

Engines. Dual Valve Motors in Expanded Pierce Truck Line. Automotive Manufacturer, vol. 42, no. 6, Sept. 1920, pp. 7–10, 7 figs. Engine is of four cylinder T-head type with $4^1/_2$ inch bore and $6^3/_4$ inch stroke. Its S.A.E. horsepower is 32.4, but at governed speed of 1200 r.p.m. it will develop 60 horsepower under normal conditions.

Frames. Two-ton Truck has Novel Frame Construction. Automotive Industries, vol. 43, no. 15, Oct. 7, 1920, p. 717, 3 figs. Channel steel frame employed in Lorain serves chiefly to hold axles in alignment and pay load is carried on wood sills fitted outside steel members and is centered over rear springs.

Oil Tanks. Oil-Tank Truck Specifications, F. A. Bean. Power Wagon, no. 191, Oct. 1920, pp. 33–35 and p. 66. Specifications suggested by writer, who is consulting engineer, Wayne Oil Tank & Pump Co.

Pneumatic Tires. Data on Pneumatic Tires and Rims Used on Trucks, Burgess Darrow. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 366–368, 7 figs. Constructional details of standard pneumatic tires.

Pneumatic-Tire and Motor-Truck Development Experiences, M. D. Scott. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 375–377. Experience of Goodyear Tire & Rubber Co., Akron, O. Data given in regard to costs, efficiency, and loading capacity of motor trucks equipped with pneumatic tires.

What Motor Trucks Need to Supplement Pneumatic-Tire Equipment, E. W. Templin. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 369–374 and 398, 12 figs. Changes in design consequent upon adoption of pneumatic tires for motor trucks.

Why Use Pneumatic Tires for Motor Trucks? W. E. Shively. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 363–365 and (discussion) pp. 377–384. Advantages gained from use of pneumatic tires.

Specifications. Internal-Combustion Truck Specifications. Power Wagon, no. 191, Oct. 1920, pp. 42–59. List with particulars of 570 principal types.

MOTORSHIPS

Danish-Built. The Motor Ship Theodore Roosevelt. Engr., vol. 130, no. 3375, Sept. 3, 1920, p. 236, 1 fig. Built at yard of Burmeister & Wain, Copenhagen. Dimensions: Length overall, 444 ft. 4 in.; breadth on frame, 55 ft.; depth from lower deck, 22 ft. 6 in.; draught, loaded, 29 ft. 1 in.; gross tonnage, 7116 tons; fuel-oil capacity, 1282 tons; radius of action, 30,000 miles.

Diesel-Engined. Bibby Lines Motorships "Dorsetshire" and "Somersetshire." Motorship, vol. 5, no. 10, Oct. 1920, pp. 889, 1 fig. Two new twin-screw Diesel-Driven vessels of 12,000 tons d.w.c. Dimensions: Length between perpendiculars, 450 ft.; breadth, 57 ft. 3 in.; depth, 33 ft. 7 in.; power of main engines, 4500 i.hp.

Another 22,000 Tons Displacement Motorship. Motorship, vol. 5, no. 11, Nov. 1920, p. 988, 1 fig New 14-knot passenger-cargo Diesel-driven liner building for East Asiatic Co. Dimensions: fuel-oil capacity, 1960 tons; hp. of main engine, 6000 i.hp.; length 502 ft.; breadth molded, 64 ft.; depth, 43 ft.

European-Built. European Motorship Building. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 834–836, 2 figs. Survey of types under construction.

Machinery for. Review of Motorship Machinery Problems, Hubert C. Verhey. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 830–832. Opposed piston-type engines. Novel scavenging pumps. Engine-room arrangements and auxiliaries. Diesel-electric drive.

Steamships vs. Cargo Motorship vs. Steamships—II, Charles E. Lucke. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 837–841. Fixed annual expenses and service expenses. Cost of cargo transportation, net earnings and investment returns.

Motorships vs. Steamships, Charles E. Lucke. Motor hip, vol. 5, no. 10, Oct. 1920, p. 910. Comparative operating expenses and earnings of cargo vessels. (Continuation of serial.)

Motorships vs Steamships—III, Charles E. Lucke. Motorship, vol. 5, no. 11, Nov. 1920, pp. 995–996. Comparative operating expenses and earnings of cargo vessels. (Concluded.)

N

NATURAL GAS

Conservation of. Conservation of Gas, L. B. Denning. Natural Gas & Gasoline Jl., vol. 14, no. 9, Sept. 1920, pp. 261–262. Work done by National Committee on Natural Gas Conservation, which consists of four representatives of public-four representatives of gas-producing companies, and two representatives of Dept. of Interior. Set of rules and regulations drawn up by committee is given.

Curtailment in Industry. Chemical Industries Likely to Lose Natural Gas Supply, R. S. McBride. Chem. & Metallurgical Eng., vol. 23, no. 15, Oct. 13, 1920, pp. 743–744, 4 figs. Investigations being conducted by State Public Service Commissions of West Va., Pa., Ohio, Md. and New York, in regard to advisability of restricting use of natural gas to domestic purposes.

Gasoline Recovery from. The Recovery of Gasoline from Natural Gas (Die Gewinnung von Benzin aus Naturgas), W. Heyn. Automobil-Rundschau, vol. 19, no. 15–16, Aug. 1920, pp. 149–153, 4 figs. Describes process for which a simple and comparatively cheap distillation plant is required, consisting of a compressor, a condenser, a separator, a collecting tank and a mechanically operated safety valve.

Utilization and Conservation. Mud Process in Saving Gas, A. W. Ambrose. Gas Rec., vol. 18, no. 6, Sept. 22, 1920, pp. 31–33. Method of preventing waste while drilling for gas and oil.

NAVIGATION

Submarines, Navigational Obligations. Modern Marine Problems in War and Peace, C. V. Drysdale. Jl. Instn. Elec. Engrs., vol. 58, no. 293, July 1920, pp. 572–597. Account of scientific investigations which have been carried out in marine problems during and after the war under British Admiralty at various experimental stations. Work during war consisted chiefly of devising means for detecting submarines. Eleventh Kelvin Lecture.

[See also RADIO COMMUNICATION, Guiding Aerial and Marine Craft.]

NICKEL-CHROMIUM STEEL

Temper-Brittleness. Temper-Brittleness of Nickel-Chromium Steels, R. H. Greaves, and J. J. A. Jones. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 4, 48 pp., 12 figs. Experimental investigation of (1) range in which temper-brittleness is produced, (2) rate at which it is produced, (3) susceptibility of certain steels to develop temper-brittleness, and (4) effect of change from brittle to tough condition on few of physical properties of steel. Theories regarding cause of temper-brittleness are discussed.

NICKEL-IRON ALLOYS

Constitution. The Constitution of the Nickel-Iron Alloys, D. Hanson and Hilda E. Hanson. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 5, 20 pp., 31 figs. Investigation into constitution of nickel-iron alloys. Special attention was given to determination of effect of small quantities of nickel on critical points of pure iron. Osmond's theory of nickel-iron alloys is examined, and attempt is made to construct "stable" diagram of nickel-iron alloys.

NOZZLES

Steam Action in. Steam Action in Simple Nozzle Forms. A. L. Mellanby and Wm. Kerr. Eng., vol. 110, no. 2853, Sept. 3, 1920, pp. 310–314, 15 figs. Charts giving pressure ratio curves for various types, constructed from results obtained from experiments. Paper read before Eng. Section, British Assn. for Advancement of Science.

O

OFFICE MANAGEMENT

See INDUSTRIAL MANAGEMENT, Office Management.

OIL

Flow in Pipes. See FLOW OF OIL, Pipes.

OIL ENGINES

Fairbanks-Morse. The Fairbanks-Morse "C-O" Marine Oil Engines. Practical Engr., vol. 62, no. 1752, Sept. 23, 1920, pp. 201–203, 5 figs. Outstanding features are (1) no water injection into cylinders, (2) water jacketing of combustion chamber and exhaust manifold, and (3) special means for quick starting.

Marine. A High-Compression Marine Oil Engine. Engr., vol. 130, no. 3375, Sept. 3, 1920, pp. 224–226, 5 figs. Built by Plenty & Son, Ltd., Newbury, England. Engines are manufactured with two sizes of cylinders, 270 mm. bore by 300 mm. stroke and 335 mm. by 350 mm. grouped according to power required.

[See also DIESEL ENGINES; SEMI-DIESEL ENGINES.]

OIL FIELDS

Argentine. Petroleum in Commodoro Rivadavia (El petró leo en Commodoro Rivadavia), Walter C Kretz. Ingenieria Internacional, vol. 4, no. 4, Oct. 1920, pp. 195–201, 7 figs. Description of oil fields and methods of exploitation.

Bolivia. Bolivia as a Source of Petroleum Supply Petroleum Times, vol. 4, no. 90, Sept. 25, 1920, p. 312. Nature of oil deposits. Conditions governing concessions of oil lands.

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ENGINEERING INDEX (Continued)

OIL FUEL

Burning Efficiency. Unusual Efficiencies with Oil Fuel, Joseph Pope and Frank G. Philo. Elec. World, vol. 76, no. 15 Oct. 9, 1920, pp. 730–732, 3 figs. Using fuel oil with mechanical atomizers with electric company is said to have obtained boiler efficiencies of 80 per cent with 300 per cent boiler rating.

Combustion. Importance and Utilization of Liquid Fuels (L'intérèt et l'utilisation des combustibles liquides), M. Dumanois. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 132, no. 4, July-Aug. 1920, pp. 436–457. Conditions to secure good combustion. Comparative values of oils found in different parts of the earth.

Passenger Ships. Oil Fuel on Passenger Ships. Shipbuilding and Shipping Rec., vol. 16, no. 13, Sept. 23, 1920, pp. 373–376. Report of Board of Trade Committee on prevention of fire on passenger ships burning oil fuel. Minimum flash point. Precautions proposed.

OIL SHALES

Utilization. The Oil Shale Industry in Scotland and England. Am. Gas Eng. Jl., vol. 113, no. 14, Oct. 2, 1920, pp. 255–260 and p. 265. Analyzes methods employed abroad and bases suggestions on these findings for utilization of American shales.

OIL TANKS

Measuring Liquids in. Measuring Liquids in Ships' Tanks. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 841–843, 3 figs. Operation of tank gage and draft indicator.

ORE DRESSING

Classifier Efficiency. Classifier Efficiency, R. T. Hancock. Eng. and Min. Jl., vol. 110, no. 13, Sept. 25, 1920, pp. 622–623. Improvement over former methods of determination suggested. Elutriation preferable to screening tests.

OXY-ACETYLENE WELDING

Automobiles. Autogenous Welding in the Citroen Automobile Factory (Die autogene Schweissung in der Automobilfabrik Citroen). Autogene Metallbearbeitung, vol. 13, no. 11, June 1, 1920, pp. 118–124, 3 figs. Includes illustrations of auxiliary welding devices and of the numerous welded automobile parts. From report of the Swiss Acetylene Assn.

Characteristics of Welds. Characteristics Peculiar to Oxy-Acetylene Welds, Alfred S. Kinsey. Welding Engr., vol. 5, no. 9, Sept. 1920, pp. 23–24. One of characteristics noted is its applicability to all kinds of metals. Paper read before Joint Meeting, New York Section Am. Soc. M.E. and Am. Welding Soc.

OXYGEN

Liquid. See EXPLOSIVES, Liquid Oxygen.

P

PAINTS

Exposure Tests. Report on Paint Exposure Tests at Atlantic City, New Jersey, Henry A. Gardner. Am. Architect, vol. 118, no. 2337, Oct. 6, 1920, pp. 445–449, 6 figs. Further account of paint exposure test panels consisting of wood and metal, both bare and coated with various types of paint and varnish, exposed on Young's Million Dollar Pier at Atlantic City, N. J., and described in Am. Architect issue of Aug. 27, 1919.

PATTERNMAKING

Plants. Pattern-Making Plant Notable for its Size, J. E. McDonald. Iron Age, vol. 106, no. 14, Sept. 30, 1920, pp. 834–836, 5 figs. Plant of Bryan Pattern & Machine Co., Bryan, Ohio. It is provided with modern equipment for turning out patterns of all kinds quickly.

PAVEMENTS

Comparative Values of. Costs on Four Types of Pavement in Philadelphia Test Road. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 607–608. Twenty-six sections, comprising bituminous macadam, mixed and penetration methods, concrete and vitrified block compared.

PAVEMENTS, ASPHALT

Maintenance Costs. Sheet Asphalt Maintenance Costs in District of Columbia, F. S. Besson. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, pp. 705–707. Use of salvaged material makes cost $1.74 square yard, including asphalt cost, haulage, cutting out, working patch.

Specifications. Specifications for Asphalt Pavements. Good Roads, vol. 20, no. 14, Oct. 13, 1920, pp. 186–187. Prepared by technical committee of Asphalt Assn., New York, N. Y.

PAVEMENTS, BRICK

Monolithic. Monolithic Brick Pavement Fails from Expansion, M. W. Watson. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, pp. 595–596, 3 figs. Experience in Kansas highways. Heat caused brick slabs to separate from concrete base and finally to rupture with violence.

PAVEMENTS, CONCRETE

Handling Concrete Material. New Method of Handling Concrete Material on Minneapolis Paving Job, Ellis R. Dutton. Mun. and County Eng., vol. 59, no. 3, Sept. 1920, pp. 22–24, 3 figs. Truck tractor having dumping body used in connection with bucket loader.

PAVEMENTS, STONE

Granite-Block. Method of Constructing Duras Pavement, W. C. Mallonee. Eng. & Contracting, vol. 54, no. 14, Oct. 6, 1920, pp. 351–352, 2 figs. Granite block pavements laid upon concrete foundation.

PAVEMENTS, WOOD-BLOCK

Comparative Value of Woods. Utility of Hardwoods for Paving Shown in Comparative Tests, E. E. Butterfield. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 656–658. Relative insusceptibility to expansion through water absorption, and greater strength are said to recommend oaks and hickory.

Tightening Blocks. Jackscrews Tighten Wood Block Pavement in Place, W. W. Horner. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, pp. 686–689, 3 figs. Method developed at St. Louis, Mo. Pavement is cut in two at intervals and blocks on each side of cuts are tightened up with jackscrews.

PETROLEUM

Hydrocarbons, Distillation of. Continuous Process and Apparatus for the Complete Destructive Distillation of Petroleum Hydrocarbons and Coal Tar (Kontinuierliches Verfahren und Apparatur zur vollständigen destruktiven Destillation von Erdölkohlenwasserstoffen und Kohlenteer). Petroleum, vol. 16, no. 5, June 10, 1920, pp. 145–147, 3 figs. Describes patented process by which residual is injected continuously or periodically into a vertical or inclined muffle of fire clay or other refractory material.

Peru and Bolivia. The Prospects for Petroleum Production in Peru and Bolivia, Charles S. Haley. Eng. & Min. Jl., vol. 110, no. 16, Oct. 16, 1920, pp. 772–774. High cost of development, difficulties of transportation, high royalties asked and objection to long-term concessions are drawbacks to exploitation of oil possibilities in these countries.

Residuals. Characteristics of Steam-Distilled Petroleum Residuals, B. A. Anderton. Can. Engr., vol. 39, no. 15, Oct. 7, 1920, pp. 411–414, 11 figs. Tests of consistency with progress of distillation. Paper presented before Am. Soc. for Testing Matls.

Water in, Determination. Bureau of Mines Method for Determining Water in Petroleum, E. W. Dean and W. A. Jacobs. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2159, Sept. 1920, 3 pp. New method employs specially constructed distilling tube receivers.

[See also OIL FIELDS.]

PHOTOTELEGRAPHY

Electrical Transmission of Pictures. The Electrical Transmission of Pictures, Philip R. Coursey. Nature (Lond.), vol. 106, no. 2656, Sept. 23, 1920, pp. 115–116, 1 fig. Modification of Baine's early chemical telegraph.

PINE

Crushing Strength. Crushing Strength of Southern Pine at Angles to Grain, Q. C. Ayres. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 653–564, 2 figs. Comparative plots of results of tests and of Jacoby and Howe formulæ for same terminal values.

[See also FIR.]

PIPE, CONCRETE

Joints. New Type of Concrete Pipe Joint. Concrete Products, vol. 19, no. 3, Sept. 1920, pp. 31–32, 4 figs. Machined castings used for bell and spigot rings.

PIPE LINES

Fuel-Oil. Oil Pipe Lines, C. P. Bowie. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2164, Sept. 1920, 4 pp. Operation of pipe-line system.

Havre-Paris. Havre-Paris Pipe Line (La pipe line Havre-Paris). Outillage, vol. 173, nos. 37 and 38, Sept. 16 and 23, 1920, pp. 570–574 and 586–589, 11 figs. Details of construction and operation of pipe lines in Roumania, England and Mexico, are studied as preliminary basis for designing Havre-Paris pipe line. (Continuation of serial.)

The Havre-Paris Pipe Line (Une opinion sur la "pipe line" Le Havre-Paris), André Guiselin. Chaleur et Industrie, no. 5, July-Aug. 1920, pp. 259–264. Discusses feasibility of project.

PIPE, WOOD-STAVE

Spirally-Reinforced. The Use of Wooden Pressure Pipe in Norway (Die Anwendung von hölzernen Druckleitungen in Norwegen), A. H. Lem. Schweizerische Bauzeitung, vol. 76, no. 9, Aug. 28, 1920, p. 101, 6 figs. Describes spirally reinforced pipes manufactured in factory in lengths of 5 m.; and continuous pipes which are put together from wood-staves at place of installation, only the parts being fabricated in factory.

PNEUMATIC TOOLS

See DRILLS, Pneumatic.

PORTS

Lorient, France. Lorient—A Fishing Port (Lorient, port de pêche). Bulletin technique du Bureau Veritas, vol. 2, no. 9, Sept. 1920, pp. 173–178, 5 figs. Project for modernizing port. It is intended to build suitable terminal facilities and cold storage plant and packing establishments, as well as railway terminals.

Vancouver, B. C. Port of Vancouver and Proposed Development, W. G. Swan. Can. Engr., vol. 39, no. 14, Sept. 30, 1920, pp. 381–382. Proposed improvement which is modelled upon Montreal harbor, involves widening and deepening First Narrows, and construction of dam and lock for Second Narrows. Paper read before Eng. Inst. of Canada.

POWER TRANSMISSION

Sonic Waves. The Transmission of Power by Waves through Liquids. Dorman Wave Power Tools (Catalogue), 68 pp., 32 figs. Applicances originated and designed by W. H. Dorman & Co., Ltd., Stafford, England, British licensees and manufacturers of wave portable, percussion and rotary tools. Wave transmission equipment consists of wave generator, wave motor and wave transmission pipe line. Generator sets up pressure impulses which travel through column of fluid contained in metal pipe and give up their energy to motor. There is no continuous flow, but fluid progressively moves forward and backward about mean positions. System was invented by George Constantinesco. Tools described are rock drills, tunnelling columns and riveting hammers. System of wave transmission is said to afford large economic and practical advantages over compressed air. Technical explanation of system is appended.

Transmission of Energy by Vibrations of Water in Conduits (Sur la transmission de l'energie par les vibrations le l'eau dans les conduites), C. Camichel. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 11, Sept. 13, 1920, pp. 515–516. Note on Constantinesco system of power transmission by "sonic" waves.

PROPELLERS, SHIP

Design. Characteristics of a Marine Propeller in a Non-Uniform Stream, T. B. Abell. Engr., vol. 130, no. 3378, Sept. 24, 1920, p. 291, 3 figs. Notes on design of ship propeller.

PUBLIC UTILITIES

State vs. Local Regulation. State Versus Local Regulation of Public Utilities, William J. Hagenah. Elec. Rev. (Chicago), vol. 77, no. 12, Sept. 18, 1920, pp. 435–442. It is claimed that stage regulation is successful, while local or municipal control proves unsatisfactory to utilities and public. Paper presented before Nat. Elec. Light Assn.

PULLEYS

Compressed-Spruce. An Investigation of Compressed Spruce Pulleys, George S. Wilson. Belting ing & Transmission, vol. 17, no. 7, Oct. 5, 1920, pp. 25–27, 2 figs. Results alleged for comparative tests with standard types and details of construction. Comment on tests by practical authorities appended. Last article is from proceedings of Washington State section, Am. Soc. Mech. Engrs. Comment is original.

PULVERIZED COAL

Boiler Firing. Recent Progress in the Firing of Boilers with Pulverized Coal (Recénts progrès réalisés dans le chauffage des chaudières par l'emploi des combustibles pulvérisés). Chaleur & Industrie, no. 3, May 1920, pp. 147–151, 3 figs. Scheme which is said to have effected satisfactory burning of powdered Alpine ashy anthracite which it has not been possible in former tests to burn with good thermal efficiency.

Burners. Powdered Fuel for Chemical Plants, H. D. Savage. Combustion, vol. 3, no. 4, Oct. 1920, pp. 32–33, 1 fig. "Lopulco" feeder and metallurgical burner.

Cost. Pulverized Coal in the Power Station, L. C. Harvey and E. E. Noble. Elecn., vol. 85, no. 2211, Oct. 1, 1920, pp. 393–396, 1 fig. Comparative cost figures for hand and pulverized coal firing of boilers. (Concluded.)

Combustion of. Pulverization and Gassification of Coal (Charbon pulvérisé et gazogène), G. Marconnet. Chaleur & Industrie, no. 3, May 1920, pp. 132–135, 3 figs. Technique of burning powdered or gassified coal.

Locomotives. Pulverized Coal Burning Equipment for Europe. Ry. Mech. Engr., vol. 94, no. 9, Sept. 1920, pp. 581–582. Description of locomotives recently designed to utilize low-grade coals in Ital and Holland.

PUMPING STATIONS

Italy. The Pumping Plant of the Viverone Hydraul Storage Plant (Die Pumpen-Anlage des hydrau ischen Kraftakkumulierungswerkes Viverone), G. Müller. Schweizerische Bauzeitung, vol. 76, nos. 12 and 13, Sept. 18, and 25 1920, pp. 129–132 and 143–146, 17 figs. Description of largest existing storage plant completed in 1913 and serving exclusively for storage purposes—regulation and equalization of energy for the numerous hydraulic power installations of the Società Anonima Elettricità Alta Italia. Details of Sulzer 4500-hp. high-pressure pumps running at 735 r.p.m., etc.

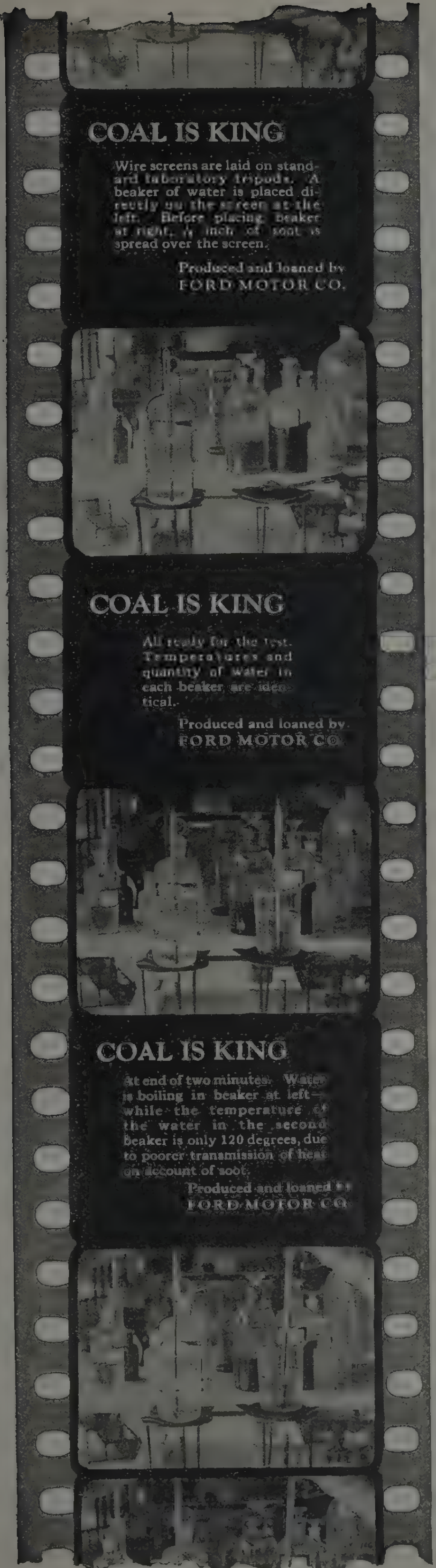
PUMPS, CENTRIFUGAL

Hydraulic Drive. A Centrifugal Bilge Pump with Water-Motor Drive (Eine durch Druckwasser betriebene Kreiselpumpe zum Lenzen), F. Lawaczeck. Fördertechnik u. Frachtverkehr, vol. 13, nos. 14 and 15, July 9 and 23, 1920, pp. 125–127 and 135–137, 7 figs. Discussion of practical results, efficiency and speed of new type of portable pump operated by water pressure.

Q

QUAY WALLS

Design. Special Quay Wall for Shores which Require Filling. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 658–659, 4 figs. Precast concrete piles form face wall with precast concrete ties to hold them against shore fill.



COAL IS KING

Wire screens are laid on standard laboratory tripods. A beaker of water is placed directly on the screen at the left. Before placing beaker at right, 1/16 inch of soot is spread over the screen.

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COAL IS KING

All ready for the test. Temperatures and quantity of water in each beaker are identical.

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COAL IS KING

At end of two minutes. Water is boiling in beaker at left—while the temperature of the water in the second beaker is only 120 degrees, due to poorer transmission of heat on account of soot.

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Laboratory Tests Point the Way to Greater Boiler Efficiency

What the Moving Pictures Show

Scene: Chemical Laboratory of Ford Motor Company.

Occasion: Production of motion picture "Coal Is King." (This film deals with all phases of coal conservation in the boiler-room. It has been shown before several hundred American engineering societies.)

Action: Test to illustrate the bad effects of soot in preventing heat transference when allowed to accumulate on boiler tubes.

Results: The pictures tell the story—water is boiling in the beaker with clean surface exposed to flame, whereas it has only reached a temperature of 120 degrees in the beaker with soot insulated surface.

> When soot accumulates on the heating surface of a boiler the result is identical with that obtaining with the soot insulated beaker. A large part of the heat is lost because it is not transmitted to the water. This means excessively high coal bills, and poor, uncertain service from the boiler. Obviously high efficiency in the generation of steam is dependent upon the maintenance of the cleanest of clean heating surfaces.

In thousands of boiler-rooms, "Cleanliness," and "Diamond Soot Blowers" are synonymous terms. Diamond Soot Blowers clean large portions of the boiler which cannot be reached by the hand lance, and clean those which can be so reached, better. As compared to the best possible results by hand cleaning, Diamond Soot Blowers will—save 4 percent to 8 percent fuel—increase overall boiler efficiency—and decrease labor required in the boiler-room.

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ENGINEERING INDEX (Continued)

R

RADIO COMMUNICATION

Guiding Aerial and Marine Craft. An Electrical Signaling Method for Guiding Aerial and Marine Craft, Robert H. Marriott. Proc. Inst. Radio Engrs., vol. 8, no. 5, Oct. 1920, pp. 345–357, 3 figs. Signal carrying conductor along course of vessel, and means capable of indicating proximity and direction of signal conductor are described and discussed, including various forms and combinations. Ocean-going vessels entering harbors are chiefly considered, same principle being applicable to other craft and channels air ships, and so on. Experimental tests of system are given in detail, with numerical data.

High-Power Continuous Apparatus. High Power Continuous Wave Radio Apparatus. Sci. Am. Monthly, vol. 2, no. 2, Oct. 1920, pp. 161–166, 9 figs. Alexanderson system for radiotelegraph and radiotelephone transmission.

RADIOTELEGRAPHY

ntennae. Quantitative Experiments with Coil Antennas in Radio Telegraphy, Louis W. Austin. Proc. Inst. Radio Engrs., vol. 8, no. 5, Oct. 1920, pp. 416–420 and (discussion) pp. 421–423. Formulæ for received current in loop receivers are derived and compared with series of observations at various wave lengths.

The Regulation of Receiving Antennae (Le réglage des antennes de réception), Michel Adam. Radio électricité, vol. 1, no. 3, Aug. 1920, pp. 148–153, 9 figs. Scheme for regulating antennae by means of simple coil and condenser. (To be continued.)

The Wave Length Relation for a Generalized Bessel's Antenna, A. Press. Proc. Inst. Radio Engrs., vol. 8, no. 5, Oct. 1920, pp. 441–447, 3 figs. Differential equations for antenna of negligible resistance and leakage conductance. Solution is obtained in terms of Bessel's Functions for voltage and current disbritution along antenna.

International Regulations. International Regulations (Réglementations internationales), P. Brenot. Radioélectricité, vol. 1, no. 3, Aug. 1920, pp. 154–165. Legislation adopted at conferences in London in 1912, Paris in 1912–1913 and London in 1913–1914. (To be continued.)

Intervalve Transformers. The Design of Intervalve Transformers, J. K. Catterson-Smith. Elecn., vol. 85, no. 2211, Oct. 1, 1920, pp. 388–390, 10 figs. Application to low-frequency aperiodic magnifiers used in radiotelephonic circuits. (To be concluded.)

Long-Distance Transmission. The Efficiency of Aerials and the Power Required for Long Distance Transmission, G. W. O. Howe. Eng., vol. 110, no. 2854, Sept. 10, 1920, pp. 357–359, 9 figs. Calculations, and equations. Paper read before Eng. Section, British Assn. for Advancement of Science.

New Stations. New Stations. Radio Service Bulletin, no. 42, Oct. 1, 1920, pp. 2–8. Lists of commercial land and ship stations, alphabetically by names of stations.

Proposed Network of Wireless Communication, J. H. Rodgers. Mar. Eng. and Can. Merchant Service Guild Rev., vol. 10, no. 7, July 1920, pp. 180–181, 2 figs. Plan, as proposed by Marconi Wireless Telegraph Company to British Government, is hoped to relieve abnormal congested condition of submarine cable service.

Static Interference. Static Elimination by Directional Reception. Greenleaf W. Pickard. Proc. Inst. Radio Engrs., vol. 8, no. 5, Oct. 1920, pp. 358–394 and (discussion) pp. 395–415, 30 figs. Writer considers possible origins of static and inclines toward solar origin. He finds that static comes from all directions, with maximum intensity from above and maximum frequency from horizon. Probable static wave form is single highly damped pulse.

RADIOTELEPHONY

Aircraft, Application to. Duplex Wireless Telephony: Some Experiments on its Application to Aircraft, P. P. Eckersley. Jl. Instn. Elec. Engrs., vol. 58, no. 293, July 1920, pp. 555–565 and (discussion) pp. 565–571. Experiments on duplex wireless telephony for aircraft carried out at Wireless Experimental Establishment of Royal Air Force.

RAILS

Rupture of Fish Joints. Cause of Rupture of Rails at Fish Joints (Cause de la fréquence des ruptures de rails dans leurs extrémités éclissées), Charles Frémont. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 6, Aug. 9, 1920, pp. 341–342. Discontinuity of rail at joint constitutes point of less resistance and, for a given load, occasions elastic flexure greater than at any other point. Hence greater bending and stresses in rail unequally distributed throughout mass.

RAILWAY ELECTRIFICATION

C., M. & St. P. Ry., Operating Results. Electric Power Consumptin on the Rocky Mountain and Missoula Divisions of the C., M. & St. P. Rwy., Reinier Beeuwkes. Gen. Elec. Rev., vol. 23, no. 9, Sept. 1920, pp. 724–730, 5 figs. Operating statistics for 1919. Cost per actual kilowatt-hours delivered to locomotives is given as 1.1 cents.

Erie R. R. Single Phase Electrification on the Erie, Q. W. Hershey. Ry. Rev., vol. 67, no. 15, Oct. 9, 1920, pp. 540–542, 3 figs. Account of electrification of 37-mile branch of Erie Railroad in Genesee valley, south of Rochester, N. Y.

Single-Phase in Thirteen Years Successful Operation on the Erie, Q. W. Hershey. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 460–463, 3 figs. Car records.

France. The Harnessing of the Dordogne River and the Electrification of the Orléans Railway (L'aménagement hydraulique du bassin de la Dordogne et l'électrification du réseau de la Compagnie du Chemin de fer d'Orléans), G. Tochon. Génie Civil, vol. 77, no. 10, Sept. 4, 1920, pp. 190–193, 2 figs. Projected hydroelectric plants. (Concluded.)

Grand Trunk Ry. Result of Twelve Years' Heavy Haulage, R. L. Hermann. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 480–482. Average cost of maintenance of electric locomotive equipment, material and labor up to Dec. 1914 was 4.514 cents per locomotive-mile, and from Dec. 1914 to Dec. 1919, 7.051 cents per locomotive-mile.

RAILWAY OPERATION

Car Records. Car Records and their Relation to Transportation and Car Accounting, J. D. Altimas. Can. Ry. & Marine World, no. 272, Oct. 1920, pp. 535–537. Paper read before Can. Ry. Club.

Looking after a Big Family of Freight Cars. Can. Machy., vol. 24, no. 15, Oct. 7, 1920, pp. 321–325, 7 figs. Method of handling reports in car record office of Canadian Pacific Railway.

Economics. The Transportation Engineer and Railway Economics. Eng. News-Rec., vol. 85, no. 15, Oct. 7, 1920, p. 693. New position suggested to insure broader views of operating problems and their economic relations.

Outlying Switches. Centralizing the Operation of Outlying Switches, J. E. Saunders. Ry. Age, vol. 69, no. 15, Oct. 8, 1920, pp. 621–622. It is argued that remote control of switches means increased track capacity, safety and economy in train service.

RAILWAY SIGNALING

Automatic System. Automatic Train Control on the Cincinnati Indianapolis & Western R. R. Ry. Rev., vol. 67, no. 14, Oct. 2, 1920, pp. 496–498, 4 figs. Electrically operated signal and stop system designed on closed circuit principle, so that opening of any closed circuit operates on side of safety.

RAILWAY TIES

Metal vs. Wooden. The Relative Merits of Metal Versus Wooden Ties. Bul. Am. Ry. Eng. Assn., vol. 22, no. 227, July 1920, pp. 15–71, 18 figs. Report made by Committee on Ties to Am. Railroad Assn. It is said that no substitute tie has as yet been developed which can be recommended for general use on high speed insulated track. Development of substitute ties is recommended as means of conserving available timber supply. Statements made to urge introduction of substitute tie on claim that safe track cannot be maintained with wooden ties are said to be without foundation and contrary to facts.

RAILWAY TRACK

See SNOW PLOWS.

RAILWAYS

Safety Work. The Economic Value of Railway Safety Work, Samuel O. Dunn. Ry. Age, vol. 69, no. 15, Oct. 8, 1920, pp. 605–607. Survey of improvements in railway accident record within last decade. Paper read before Nat. Safety Council.

RECOVERANCE

See MATERIALS, Testing.

REFRACTORIES

Zirkite. Resistance of Zirkite to Slag Corrosion. Iron & Coal Trades Rev., vol. 101, no. 2740, Sept. 3, 1920, p. 291. Experiments showed that Zirkite is affected by fluorides or fluorine vapors.

RESEARCH

Agricultural. Scientific Research in Relation to Agricultural Problems. Science, vol. 52, no. 1344, Oct. 1, 1920, pp. 301–307. Address delivered at organizing convention of Can. Soc. of Technical Agriculturists, Ottawa, June 3, 1920.

Egyptian Government Analytical Laboratory. Egyptian Analytical Laboratory and Assay Office, A. Lucas. Chem. Age (Lond.), vol. 3, no. 64, Sept. 4, 1920, pp. 256–257. Report on work of Government Analytical Laboratory and Assay of Office during period of 1913–1919. Report emphasizes need of industrial research and of thoroughly up-to-date scientific library for general reference.

Industrial. Relations between Science and Industry and the Societies for Industrial Advancement (Les relations entre la science et l'industrie et les sociétés de perfectionnements industriels), R. d'Adhémar. Revue générale des Sciences, vol. 31, nos. 15–16, Aug. 15–30, 1920, pp. 513–519. Advantages of industrial research.

Scientific and Industrial Research. Chem. Age (Lond.), vol. 3, no. 67, Sept. 25, 1920, pp. 332–334. Also Gas World, vol. 73, no. 1888, Sept. 25, 1920, pp. 228–229. Fifth annual progress report of British Committee of Privy Council for Scientific and Industrial Research.

Science and the Industries, John J. Carty. Reprint & Circular Series of Nat. Research Council, no. 8, 16 pp., 2 figs. Address delivered under auspices of Nat. Research Council, Washington, D. C., Feb. 6, 1920.

The Engineer in Industry, Edward A. Deeds. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 331–333. Necessity for research in industry.

International Research Council. The International Organization of Scientific Research, George Ellery Hale. Int. Conciliation, no. 154, Sept. 1920, pp. 431–441. Notes on International Research Council organized at International meeting held in Brussels, July 18–28, 1919.

National Research Council. Fourth Annual Report of the National Research Council. Washington Government Printing Office, 1920, 68 pp. Council was established in 1916 at request of President of United States under charter of Natl. Academy of Sciences.

Reduction of Observations. Adjustment of Parabolic and Linear Curves to Observations Taken at Equal Intervals of the Independent Variable, Harry M. Roeser. Dept. of Commerce, Sci. Papers of Bur. of Standards, no. 388, July 21, 1920, pp. 363–375. Ordinary least-square formulæ are subjected to mathematical treatment and rigorous solutions are evolved which require ultimate minimum of arithmetical work. Table is furnished from which large portion of solutions can be written down from mere inspection of observations. Application of solutions is made to typical problems and absolute check with ordinary least-square solutions is shown.

United States. The Development of Research in the United States, James Rowland Angell. Reprint & Circular Series of Nat. Research Council, no. 6, 19 pp. Address delivered before Assn. of Land-Grant Colleges at Chicago, Nov. 13, 1919. Reprinted from Proceedings of Thirty-third Annual Convention of Assn. of Am. Agricultural Colleges & Experiment Stations.

[See also CONCRETE, Research; FLOTATION, Research.]

RHEOSTATS

Liquid. The New Liquid Rheostats for the Norfolk & Western Railway, D. C. West. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 483–484. Rheostat for each truck consists of two electrode assemblies, of three electrodes each, mounted side by side in rectangular tank, which is provided with set of weirs for raising and lowering height of electrolyte around electrodes.

RIPARIAN RIGHTS

Retention by State. Riparian Rights, J. Spencer Smith. Freight Handling & Terminal Eng., vol. 6, no. 9, Sept. 1920, p. 334. Contrast is made between developments at Montreal and New Orleans, where riparian rights have been retained by state, and Jersey City, N. J., where riparian rights have not been so retained. More scientific developments on former ports is attributed to retention of such rights. Paper read before Am. Port Authorities, Chicago, Sept. 1920.

RIVER VESSELS

Coal Barges. Material for Construction of Coal Barges (Note sur le matériel de la batellerie). Bulletin technique du Bureau Veritas, vol. 2, no. 9, Sept. 1920, pp. 179–182, 3 figs. Coal barges employed for canal transportation of coal from Sarre district. Dimensions are: Length between perpendiculars, 38.35 m.; breadth, 5 m.; mean depth, 2.7 m.

RIVERS

See RIPARIAN RIGHTS.

RIVETING

Electric Rivet Heaters. An Electric Rivet Heater Eng., vol. 110, no. 2856, Sept. 24, 1920, p. 408, 1 fig. Apparatus consists of simple framework on wheels for carrying transformer. It is constructed by A.1 Manufacturing Co., Bradford, England.

Heating Rivets without Fire, Ellsworth Sheldon. Am. Mach., vol. 53, no. 16, Oct. 14, 1920, pp. 701–706, 16 figs. Berwick electric rivet heater.

ROAD CONSTRUCTION

Illinois. Highway Work in Illinois. Good Roads, vol. 20, no. 14, Oct. 13, 1920, pp. 179–180. 49 miles were completed during September on Federal Aid System which involves construction of 225 miles. $2,881,504 bridge and grading contracts were let.

Machinery. Novel Construction Methods Employed on Morris-Ottawa, Illinois Concrete Road, J. E. Huber. Mun. and County Eng., vol. 59, no. 3, Sept. 1920, pp. 83–85, 11 figs. Specially constructed excavator which operates like elevating grader and is equipped with caterpillar traction, its power being furnished by large gas engine.

ROAD ROLLERS

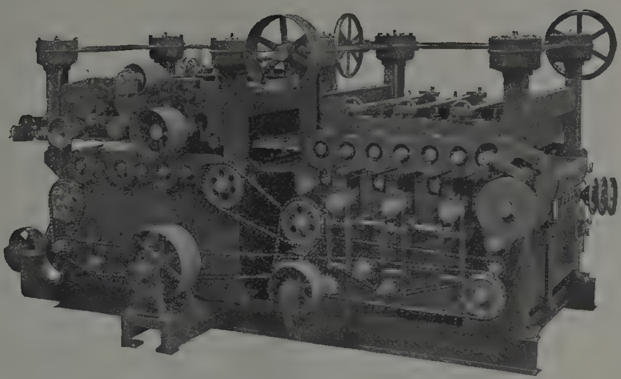
Steam vs. Electric. Power Road Rollers (Motor-Strassenwalzen), H. Jacoby. Allgemeine Automobil-Zeitung, vol. 21, no. 33, Aug. 14, 1920, pp. 24–26, 4 figs. Describes various new types and gives data of comparative costs of 12-ton steam roller and 6 to 8-ton electric roller.

ROADS

Federal-Aid Types. The Selection and Comparison of Federal-Aid Road Types, E. W. James. Eng. & Contracting, vol. 54, no. 14, Oct. 6, 1920, pp. 348–351. Paper presented before conference of District Engrs. of U. S. Bur. of Public Roads.

ROADS, CONCRETE

Construction. Central Mixing and Proportioning Plants in National Old Trails Road Construction in Illinois. Eng. & Contracting, vol. 54, no. 14, Oct. 6, 1920, pp. 339–342, 13 figs. Comparison of two methods of handling concreting, in central mixing plant or in central proportioning plant, based on experience of contractors who have used these two methods in road construction work in Illinois.



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ENGINEERING INDEX (Continued)

ROLLING MILLS

Alloy-Steel Sheets. Carbon Steel Company Jobbing Mill, J. F. Burt. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct. 1920, pp. 545–547, 5 figs. New mill used for rolling high-carbon and alloy-steel sheets and plates at Pittsburgh plant of Carbon Steel Co.

Electric. Electric Reversing Mill Considered from the Standpoint of Tonnage, K. A. Pauly. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct. 1920, pp. 541–544, 2 figs. Discussion of influence of control on rolling time, particularly to effect of limiting maximum power delivered to direct current motor driving rolls. (Abstract.) Paper read before Assn. Iron & Steel Elec. Engrs.

[See also ELECTRIC DRIVE, Rolling Mills.]

RUBBER

Permeability to Gases. Permeability of Rubber to Gases, Junius David Edwards and S. F. Pickering. Dept. Commerce, Sci. Papers of Bur. of Standards, no. 387, July 12, 1920, pp. 327–363, 9 figs. Certain of factors which determine permeability of rubber to gases were investigated and relative rates of penetration of number of gases determined. It was found, for example, that permeability to hydrogen is inversely proportional to thickness of rubber and that permeability to any gas is found to be directly proportional to its partial pressure, provided total pressure is constant.

S

SAFETY

See RAILWAYS, Safety Work.

SAND, MOLDING

Standardization. Standardization of Molding Sands, C. Powell Karr. Iron Age, vol. 106, no. 14, Sept. 30, 1920, pp. 845–849, 2 figs. Suggestions for classifying and establishing relative values. Apparatus and methods for testing. Characteristics of typical sands.

SANITATION

Works. The New Sanitation Works of Codigoro (La nouvelle installation d'assainissement de Codigoro), G. Muller. Bulletin technique de la Suisse romande, vol. 46, no. 17, Aug. 21, 1920, pp. 193–197, 9 figs. Details of pumping installation. (Continuation of serial.)

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW THREADS

Conical. Device for Cutting Conical Screw Threads (Vorrichtung zum Schneiden von konischem Aussen- und Innengewinde), Metall-Technik, vol. 46, no. 25–26, June 28, 1920, p. 97, 2 figs. Describes patented device for cutting internal and external threads which can be attached to any lathe, and is especially adapted to the machining of workpieces of large diameter, such as pipe sleeves, nipples, etc.

National Screw Thread Commission. Tentative Report of the National Screw Thread Commission. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 317–320. Tables giving proposed series of coarse-thread and fine-thread screws.

SEAPLANES

Air Ministry Competition. The Air Ministry Seaplane (Amphibian) Competition. Flight, vol. 12, no. 39, Sept. 23, 1920, pp. 1013–1021, 22 figs. Description of machines entered in British air ministry competition for amphibian machines.

SEARCHLIGHTS

Photometric Measurement. The Photometric Measurement of Searchlights (Ueber das Photometrieren von Scheinwerfern), Georg Gehlhoff. Zeitschrift für Beleuchtungswesen, vol. 26, no. 13–14, July 15–31, 1920, pp. 103–104, 3 figs. Presents curves showing difference between values for the photometric limit distance of a searchlight according to Gehlhoff and Schering and according to Erfle.

SEMI-DIESEL ENGINES

Tuxham. The Tuxham Marine Crude Oil Engines. Practical Engr., vol. 62, no. 1754, Oct. 7, 1920, pp. 234–236, 3 figs. Semi-Diesel type built on two-stroke principle.

Two-Cycle. Two-Stroke Cycle Semi-Diesel Oil Engine. Eng., vol. 110, no. 2855, Sept. 17, 1920, pp. 376 and 378, 7 figs. Built by Consolidated Pneumatic Tool Co., Ltd., London, England. Instead of employing crankcase compression engine is fitted with special compression chamber at front end of cylinder.

Vickers-Petter. The Vickers-Petter Semi-Diesel Crude-Oil Engine. Steamship, vol. 32, no. 376, Oct. 1920, pp. 83–84, 2 figs. Engine has four cylinders 12 in. diameter by 14 in. stroke, develops 152 h.bp. at 300 r.p.m. and starts and reverses by compressed air.

SEWAGE DISPOSAL

Ocean Disposal. Ocean Sewage Disposal in Relation to Bathing Beaches, Lynn Perry. Eng. News-Rec., vol. 85, no. 14, Sept. 30, 1920, pp. 640–641, 3 figs. Series of investigations conducted by State Department of Health of New Jersey. It was concluded that thoroughly settled sewage, when discharged into ocean well outside of surf, is not likely to impair bacterial quality of water at bathing beaches.

SHAFT SINKING

Gyroscopic Compass, Use in. The Gyroscopic Compass in Shaft Sinking (Der Kreiselkompass im Schachtbau), O. Martienssen. Elektrotechnische Zeitschrift, vol. 41, no. 24, June 17, 1920, pp. 462–466 and (discussion) pp. 475–476, 17 figs. Describes arrangement and use of a bore hole inclinometer equipped with a gyroscopic compass and points out its advantages in shaft sinking by the freezing process, where the bore holes through water-bearing strata must be exactly parallel and vertical.

SHAFTING

Flexible. A New Flexible Coupling. Engr., vol. 130, no. 3376, Sept. 10, 1920, p. 252. Type constructed by Wellman Bibby Co., Ltd., London, England. It is said one is being constructed to transmit 16,000 hp. for rolling mill running at 100 r.p.m.

SHIP DESIGN

Bottom, Shape of. Ship Resistance and the Ramus Principle, A. W. Johns. Eng., vol. 110, no. 2856, Sept. 24, 1920, pp. 395–397, 2 figs. Critical study of suggestions of Charles Meade Ramus to British Admiralty to adopt stepped inclined planes as shape of bottoms of ships with a view to increasing speed. Suggestion was made to admiralty in 1872 and has been since examined theoretically and experimentally.

Design Data. The Status of Ship Data, C. H. Peabody. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 797–799. Suggestions in regard to improving present methods used in displacement, stability, power and strength calculations.

Economical Speed. Economical and Profitable Speeds (Vitesses économiques et vitesses profitables). Bulletin technique du Bureau Veritas, vol. 2, no. 9, Sept. 1920, pp. 183–184. Mathematical study.

Electrical Installations. The Design of Electrical Installations for Ships, C. H. Wordingham. Elecn., vol. 85, no. 2207, Sept. 3, 1920, pp. 248–251. Advantages of ring system of conductors with sufficient control. In this system pair of conductors forming a ring is run round ship, passing through all principal compartments. Experience in British Navy with this system.

SHIP MODELS

Value of Experiments. The Applicability of the Results of Ship Model and Model Propeller Experiments to the Conditions of Ships of Full-Size (Die Uebertragbarkeit der Ergebnisse von Schiffsmodell- und Modellpropellerversuchsergebnissen auf die Verhältnisse naturgrosser Fahrzeuge), H. Schaffran. Schiffbau, vol. 21, no. 31, Sept. 1, 1920, pp. 1116–1122, 10 figs. The twin-screw passenger and freight steamer, "Berlin," is used as an example to demonstrate that the results of trial runs of ship models with propellers can be readily applied to the operating conditions of twin-size ships with the aid of the Froude test-calculating method, and offer not only relatively correct, but also absolutely practicable methods.

SHIP PROPULSION

Airscrew. Propulsion of Barges by Air Propellers (L'hélice aérienne et le halaje des bateaux sur les voies navigables), M. Bousquet. Nature (Paris), no. 2420, Aug. 21, 1920, pp. 123–126, 2 figs. Arrangement with which speed of $2^1/_2$ miles per hour has been obtained using 10-hp. engine operating six-bladed propeller.

Diesel-Engines. Application of Diesel Engines to the Propulsion of Ships (L'application du moteur Diesel à la propulsion des navires), J. Vallée. Technique Moderne, vol. 12, no. 8, Aug. 1920, pp. 321–323, 1 fig. Chart giving net tonnage of cargo-boat displacing total of 12,500 tons, for different systems of propulsion and for cruising radius varying from 0 to 80 days.

Geared-Turbine. Geared Turbine Propelling Machinery of H.M.S. "Raleigh." Eng., vol. 110, no. 2856, Sept. 24, 1920, pp. 410 and 418–419, 6 figs. Machinery consists of four identical sets, two part and two starboard, each of three turbines of Brown-Curtis impulse type. Cruising turbine is connected by clutch direct to forward end of each high-pressure turbine, which is connected in turn by flexible coupling to high-pressure pinion of single-reduction double-helical gearing. Low-pressure turbine is similarly connected to its gearing Other features of ship are also described and account of trials is given.

SHIPBUILDING

American Shipyards. Shipbuilding in American Shipyards. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 846–848. Steel vessels under construction for private account. Total construction of merchant tonnage.

SHIPS

Cargo. Cargo Steamer of 3000 Tons D.W. on 17 ft. 6 in. Draught. Shipbuilding & Shipping Rec., vol. 16, no. 14, Sept. 30, 1920, pp. 401–403, 4 figs. Dimensions: Length between perpendiculars, 270 ft.; breadth, molded, 42 ft.; depth, molded to upper deck, 20 ft.; deadweight, 3000 tons; draft, loaded, 17 ft. 6 in.

Glands for Electric Cables. British Standard Specification for Watertight Glands for Electric Cables. British Eng. Standards Assn., no. 94, 1920, 12 pp., 7 figs. Watertight glands for following purposes are included in specification: (1) decks, (2) bulkheads, (3) cast-metal boxes and (4) sheet-metal boxes. Specification was approved on July 15, 1920.

Oil-Burning Installations. Oil Burning Installation of the Aquitania. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 817–821, 4 figs. General details of oil storage, pumping arrangements and structural changes which were necessary to convert installation to oil burning. Increased speed is said to have resulted from transformation.

Passenger, Surveying. Bilge-Pumping Arrangements in Passenger Steamships, D. Hipwood. Steamship, vol. 32, no. 376, Oct. 1920, pp. 85–86. Instructions, based on recommendations of Bulkheads Committee, issued by British Board of Trade under provisions of Merchant Shipping Acts for assistance and guidance of their officers in surveying passenger steamships.

SHIPYARDS

See INDUSTRIAL MANAGEMENT, Shipbuilding.

SILVER METALLURGY

Lead-Carbonate Ores. The Shattuck-Arizona Mill for Concentrating Silver Lead-Carbonate Ores, Glenn L. Allen. Eng. & Min. Jl., vol. 110, no. 16, Oct. 16, 1920, pp. 759–762, 4 figs. How low-grade oxidized ore is concentrated at profit. Exceedingly fine crushing necessary. Table treatment and sulphidizing followed by flotation gives satisfactory lead recovery.

SNOW PLOWS

Railway. Snow Fighting Equipment, W. H. Winterrowd. Can. Ry. & Marine World, no. 272, Oct. 1920, pp. 525–529, 14 figs. Canadian Pacific Ry. rotary snow plow and other types. (Continuation of serial.)

SNOW REMOVAL

Snow Melter. A Snow-Removal Method Used in Finland. Am. City, vol. 23, no. 4, Oct. 1920, pp. 360–361, 1 fig. Hot air and combustion gases from furnace are forced straight through snow to be melted.

SPRINGS

Design. Steel Compression Springs of Circular Cross Section, T. F. Stacy. Am. Mach., vol. 53, no. 13, Sept. 23, 1920, pp. 581–582, 4 figs. Charts developed by writer in connection with his work for Hydraulic Press Manufacturing Co. Charts simplify calculations involved in design of compression springs varying in size from those used on checks of small valves to those for pull-back springs on large hydraulic presses and for shock absorbers on large weighted accumulators.

Helical. Deformation of a Helical Spring Fixed at the Ends (Déformation d'un ressort dont les extremités sont encastrées), M. Galbrun. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 7, Aug. 17, 1920, pp. 386–389. Formula for computing deformation.

STANDARDIZATION

Automotive Industry. Automotive Engineering Standardization and Progress. Coker F. Clarkson. Aviation, vol. 9, no. 5, Oct. 1, 1920, p. 158. Address delivered before Nat. Gas Engine Assn.

The Science of Standardization, Robert S. Burnett. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920; pp. 343–345. Its significance in automotive industry.

STANDARDS

German N D I Reports. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 2, no. 10, may 1920, pp. 281–303, 29 figs. Proposed standards for T-slots, dovetail slots, lubricating rings, hand and machine screw taps, hand plug taps, oil glasses, nut locks, flat hexagonal nuts, bolt heads for T and dovetail slots, and for conventions for drawings. Report of proceedings of Committee.

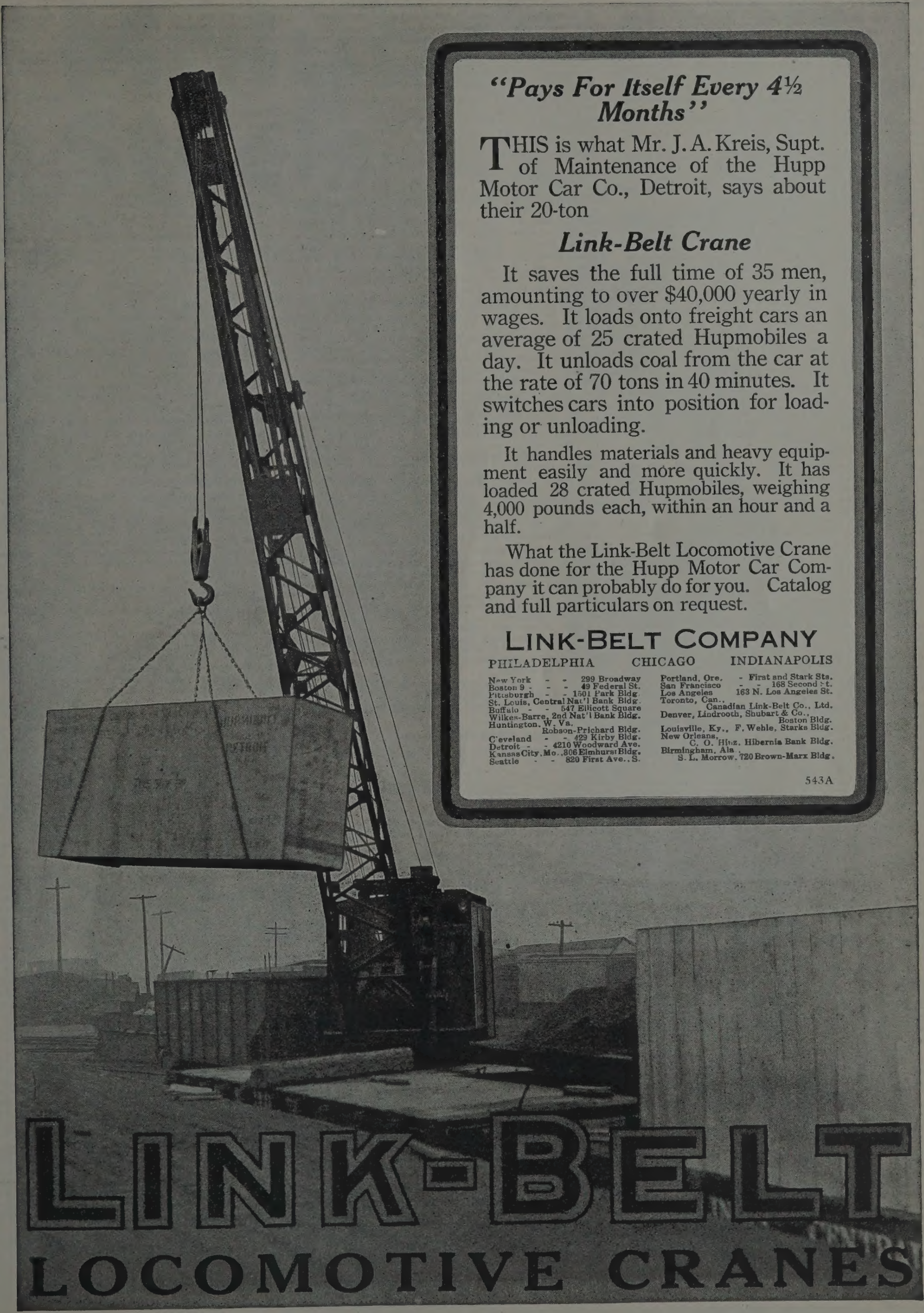
Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 2, no. 12, June 1920, pp. 329–343, 18 figs. Approved standards for wooden beams for small dwellings, and for wrench widths. Proposed standards for voltages for electric plants under 100 volts; flange couplings; knob screws and nuts, unit metric threads; rules for standards and formular values; and traversing wheels for hoisting machines with unilateral and bilateral wheel flange and without wheel flange.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 2, no. 13, July 1920, pp. 345–358, 18 figs. Proposed standards for key and feather cross-sections for solid shafts and transmission shafts; low-carbon steel and cast-iron shaft collars; machine handles with fix and revolving grips of wood or paper material; hollow set screws; wide and narrow flange bearings with two and four bolt-holes for hoisting machines; rules for standards and formular values; cast-iron pipe reducers and elbows.

Voltage. Standardization of the Working Voltages in Switzerland—VIII and IX (Zur Vereinheitlichung der Betriebsspannungen in der Schweiz), H. Wyssling. Schweiz. elektrotechnischer Verein Bul., vol. 11, no. 8, Aug. 1920, pp. 199–206, 2 figs. Contact connections of transformers and motors for use in connection with old and new voltages. Determination of standard voltage increases at sources of current as compared to standard voltages at point of current consumption.

STEAM-ELECTRIC PLANTS

Coal Mines. Generating Plant at the Mouth of Mine, G. G. Bell. Elec. World, vol. 76, no. 13,



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New Orleans, C. O. Hinz, Hibernia Bank Bldg.
Birmingham, Ala., S. L. Morrow, 720 Brown-Marx Bldg.

543A

Sept. 25, 1920, pp. 625–629, 6 figs. New Springdale plant of West Penn Power Co. Ultimate capacity will be 300,000 kw. Details of two turbo-generators of 25,000 kw. each being installed.

Kansas City, Mo. New Northeast Station at Kansas City. Power, vol. 52, no. 12, Sept. 21, 1920, pp. 450–456, 13 figs. Plans called for ultimate capacity of 270,000 kw. Plan is featured by combination high- and low-pressure economizers, submerged ashpits, vertical condensers with hydraulic vacuum nozzles, a ring bus system and other features on the electrical end.

Maintenance Costs. Analyzing Maintenance Costs. Elec. World, vol. 76, no. 13, Sept. 25, 1920, pp. 613–615, 7 figs. Comparison of monthly output, steam and electrical equipment repair costs in plant of 63,000 kva.

Pennsylvania. Springdale Power Station, West Penn Power Company, G. G. Bell. Power, vol. 52, no. 13, Sept. 28, 1920, pp. 488–496, 11 figs. Generating equipment consists of two 25,000-kva. turbo-generators. Eight double-end stokered boilers are arranged in two rows, each equipped with 13-retort stokers. Boilers are designed for 350-lb. pressure and will be operated at maximum of 250 to 300 per cent. Coal is delivered directly from company's mine to bunker in boiler house after passing through tipple where it is screened, picked and crushed.

Port Pirie, South Australia. Power Plant of the Associated Smelters at Port Pirie. Chem. Engr. & Min. Rev., vol. 12, no. 144, Sept. 5, 1920, pp. 435–440, 6 figs. There are two 3000 kw. sets, each consisting of a Fraser and Chalmers steam turbine of Rateau type, designed for steam at 200 lb. per sq. in. pressure, direct coupled with flexible coupling to Vickers 3000-kw., 375-volt, 3-phase, 50-cycle alternator, speed of set being 3000 r.p.m.

STEAM TURBINES

Brush-Ljungström. The Brush-Ljungström Steam Turbine. Practical Engr., vol. 62, no. 1753, Sept. 30, 1920, pp. 214–216, 3 figs. Set consists of cylindrical case, placed horizontally, turbine occupying remarkably small space and located between two generators. Turbine is of reaction type and has two rotors revolving in opposite directions, whereby actual running speed is practically doubled.

Ljungström. Test of 1,500-Kilowatt Ljungström Steam Turbine. Eng., vol. 110, no. 2854, Sept. 10, 1920, pp. 345–346. Economy test of Brush Ljungström turbine generator working at Lea-road Power Station of Marshall, Sons & Co., Ltd., Gainsborough, England.

Operation. Operation of Steam Turbines (Analyse du fonctionnement des turbines), Maurice Bouffart. Revue universelle des Mines, vol. 6, no. 5, Sept. 1, 1920, pp. 305–339, 6 figs. Mathematical analysis with applications to Brown-Boveri-Parsons, de Laval, Kolb-Electra, Rateau, Zoelly, Curtis, Kolb, and Sulzer-Westinghouse types. (To be continued.)

Theory of. Theory of the Steam Turbine with Special Consideration of Recent Experimental Results (Beiträge zur Dampfturbinentheorie mit besonderer Berücksichtigung neuerer Versuchsergebnisse), Herbert Melan. Zeitschrift für das gesamte Turbinenwesen, vol. 17, nos. 18 and 19, June 30 and July 10, 1920, pp. 205–208 and 22–225, 12 figs. Discussion of present status of the theory of the "mixed construction" type of turbine, based on author's investigation of a 5000-kw. turbine of the Budapest central station.

[See also MARINE STEAM TURBINES.

STEEL

Arc-Fused. Physical Properties of Arc-Fused Steel, Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan. Chem. and Metallurgical Eng., vol. 23, no. 14, Oct. 6, 1920, pp. 677–684, 8 figs. Tests cut from blocks of arc-fused metal gave mechanical properties like inferior, porous casting, notably deficient in ductility, and determined entirely by unsoundness in structure. Carbon, silicon and other elements were lost from welding pencil during decomposition.

Bar Stock, Weight of. Chart for Screw Machine Stock. Machy. (Lond.), vol. 16, no. 415, Sept. 9, 1920, pp. 713–714, 1 fig. Chart for determining weight of brass or steel bar stock.

Bars, Test of. Traction Tests of Mild Steel Bars, Both Round and Threaded (Essai à la traction de barres rondes et de barres filetées en acier doux), A Freymond. Bulletin technique de la Suisse romande, vol. 46, no. 19, Sept. 4, 1920, pp. 207–210, 2 figs. In Versuche mit Schrauben aus Schweiss- und Flusseisen gegenüber Drehung und Zug von C. Bach, Zeitschrift d.V.d.J. 1895, pp. 854–860 and 889–894 it is stated that threading increases specific resistance to traction of steel bar. Experiments reported in present article were conducted to determine amount of this increase.

Cementite. On the Formation of Spheroidal Cementite, Kôtarô Honda and Shôzô Saitô. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 8, 7 pp., 6 figs. Experiments made with steels containing 0.31, 0.56, 0.80, 0.94, 1.2, 1.59 and 1.95 per cent of carbon, and white cast iron with 3.75 pr cent of carbon. Theory explaining spheroidization of cementite is worked out from results obtained.

Deoxidation with Hydrogen. Experiments on the Deoxidation of Steel with Hydrogen, J. H. Whiteley. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 13, 14 pp., 13 figs. Two series of experiments were made, first with small sections and second with strips 1/400 in. thick. Experiments all showed that oxide is removed very slowly below 950 deg. cent.; as temperature is raised speed increased, but not until 1300 deg. cent. was used did thin strips appear to be completely deoxidized in one hour.

Electric, Manufacture of. Electric Steels, C. G. Carlisle. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 2, 23 pp., 1 fig. Tension, compression and torsion tests of steel manufacture in electric furnace, also tests of endurance. Study of suitability for die making, etc.

Intercrystalline Fracture. Intercrystalline Fracture in Mild Steel, Walter Rosenhain and D. Hanson. Eng., vol. 110, no. 2856, Sept. 24, 1920, pp. 421–422, 9 figs. Systematic observations have led writers to formulate theory that fracture of mild steel occurs mainly by breaking across of ferrite crystals and not by separation of one crystal from another. Paper read before Iron & Steel Inst.

Macrostructure. Revealing Macrostructure of Iron and Steel, Henry S. Rawdon. Iron Age, vol. 106, nol 16, Oct. 14, 1920, pp. 965–968, 7 figs. Method of etching with ammonium persulphate as agent.

Non-Magnetic. Non-Magnetic, Flame, Acid, and Rust Resisting Steel, C. M. Johnson. Am. Drop Forger, vol. 6, no. 9, Sept. 1920, pp. 423–424. Properties of steel developed in Research Dept., Crucible Steel Co. of America.

Physical and Chemical Properties, Relation of. Notes as to Rates of Reaction in Certain Steels at 930 deg. cent., E. D. Campbell and B. A. Soule. Iron and Steel Inst., Meeting, Sept. 21–22, 1920, paper no. 1, 6 pp. It was desired to determine whether when bar of steel 6 mm. square by 15 cm. long was hardened by quickly plunging it into ice water there would be detectable difference in chemical constitution between two ends of bar. It was found that difference in rate of cooling of two ends of bar produces changes in chemical constitution which result in differences in thermo-electromotive potential much in excess of anything attributable to experimental error. Differences in potential at opposite ends indicated difference in chemical constitution.

Production in U. S. Statistics of Rolled Steel Products—Smaller Tonnages in 1919 than in Preceding Year. Iron Age, vol. 106, no. 16, Oct. 14, 1920, pp. 985–987. Statistics compiled by Am. Iron & Steel Inst. showing production of steel ingots and castings and other products.

Structure Formation. The Formation of Structure by Solidification and its Improvement through annealing of the Iron (Bildung des Gefüges beim Erstarren und seine Verbesserung durch Glühen des Eisens), F. Martens. Organ für die Fortschritte des Eisenbahnwesens, vol. 57, nos. 2 and 3, Jan. 15 and Feb. 1, 1920, pp. 25–30 and 41–45, 41 figs., 21 on supp. plate. Results of tests demonstrate various ways in which structure formation can be affected by outside influences, and to what great extent the properties of steel are subjected thereby to change.

[See also EXPORT TRADE, Steel; IRON AND STEEL, Production in U. S.; NICKEL-CHROMIUM STEEL; STRUCTURAL STEEL; URANIUM STEEL.]

STEEL, HEAT TREATMENT OF

Electric Furnaces. Heat Treating Steel Electrically, E. F. Collins. Iron Trade Rev., vol. 67, no. 15, Oct. 7, 1920, pp. 990–994, 12 figs. Factors affecting uniformity and quality of castings. Advantages of electric furnaces for heat treating. Automatic control is recommended. Paper read before Am. Foundrymen's Assn.

Gas Heating. Heat Treatment Using High Pressure Gas, A. C. Roessler. Am. Drop Forger, vol. 6, no. 9, Sept. 1920, pp. 450–452, 2 figs. "Romec" system of high pressure gas heating.

Hump Method. Hump Method of Heat Treatment of Steel in Electrical Furnaces, Mr. Tall. Proc. Steel Treating Research Soc. & Jl. Am. Steel Treaters Soc., vol. 2, no. 13, pp. 18–22, 11 figs. Equipment manufactured by Leeds-Northrup Co.

STEEL, HIGH-SPEED

Forging Temperatures, Effect of. Some Effects of Forging Temperatures on Drill Steel, B. Franklin Shepherd. Compressed Air Mag., vol. 25, no. 10, Oct. 1920, p. 9833, 2 figs. Results of tests.

STEEL MANUFACTURE

Ingot Molds. Influence of Manganese Content on Duration of Molds for Steel Ingots (Influence d'une augmentation notable de la teneur en manganèse des fontes de lingotières d'acierie), M. Groschaude. Génie Civil, vol. 77, no. 10, Sept. 4, 1920, pp. 198–199, 1 fig. Molds containing from 1.75 to 2.25 per cent manganese are said to have resisted 250 casts. Diagram showing relation between manganese content and duration of mold is constructed from results of experimence in steel foundry.

STEEL MILLS

Electrical Equipment, Standardization of. Standardization of Electrical Equipment and its Relation to Accident Hazard, Walter Greenwood. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct., 1920, pp. 548–549. Standardization demanded on account of economy in construction and operation and equally so on account of lowering of accident hazard. (Abstract.) Paper read before Assn. Iron & Steel Elec. Engrs.

Power Plants. Current Limiting Reactances, R. H. Kiel. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct. 1920, pp. 554–556. Disadvantages of centralizing generating equipment. Means for aiding power house in maintaining a continuous supply of electric power on its lines. (Abstract.) Paper read before Assn. Iron & Steel Elec. Engrs.

Some Economic Considerations in Design of Power Plants for Steel Mills, T. E. Keating. Blast Furnace & Steel Plant, vol. 8, no. 10, Oct. 1920, pp. 570–574. Deals with economic centralization of power generation for various units of steel industry. How to design power plants for greatest economy. (Abstract.) Paper read before Assn. Iron & Steel Elec. Engrs.

[See also ELECTRIC DRIVE, Rolling Mills.]

STEEL WORKS

Ebbw Vale. The Electrification of the Works and Collieries of the Ebbw Vale Steel, Iron and Coal Company, Limited, Walter Dixon. Eng., vol. 110, no. 2856, Sept. 24, 1920, pp. 419–421, 5 figs. Also Engr., vol. 130, no. 3378, Sept. 24, 1920, pp. 299–300, 5 figs. Works are expected to provide after completion of improvements, annual output of 5,500,000 tons of coal, 575,000 tons of coke, and 450,000 tons pig iron. Allied industries embrace manufacture of steel rails and sleepers, galvanized steel sheets, weldless steel tubes and couplings, coke-oven and blast-furnace by-products, iron and steel castings and engineering work. Paper read before Iron & Steel Inst.

Margam. The New Margam Works of Baldwins, Ltd. Iron & Coal Trades Rev., vol. 101, no. 2742, Sept. 17, 1920, pp. 353–359, 40 figs. partly on 6 supp. plates. Self-contained unit, with coal washery, coke ovens, by-product plant, blast furnaces, steel-smelting plant and rolling mills.

Port Talbot. The Port Talbot Steel Works. Iron & Coal Trades Rev., vol. 101, no. 2742, Sept. 17, 1920, pp. 362–364, 5 figs. Melting plant has capacity of 7000 tons of ingots per week. Sections, rounds, squares, flats and light rails are largely manufactured in mills.

Waste-Heat-Operated. Steel Plant Operated with Waste Heat. Iron Age, vol. 106, no. 13, Sept. 23, 1920, pp. 765–769, 7 figs. New Works of Electric Steel & Forge Co., Cleveland, for manufacture of alloy steels. Ingots broken down under hammer.

STREET RAILWAYS

Carbon Trolley Shoes. Carbon Trolley Shoes for Street Railway Operation (Kohleschleifstücke im Strassenbahnbetrieb), H. Torau. Verkehrstechnik, vol. 37, no. 23, Aug. 15, 1920, pp. 324–325, 3 figs. It is claimed that the described defects of carbon shoes are easily corrected as soon as the trolley wire is polished to a smooth surface by the exclusive use of carbon shoes.

Cars, Safety. Foot Control of Safety Cars, B. O. Austin. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 488–490, 6 figs. Scheme used in Third Avenue safety cars, New York City.

New Standard Type of Safety Car Suggested, Wray T. Thorn. Elec. Ry. Jl., vol. 56, no. 12, Sept. 18, 1920, pp. 549–550, 1 fig. Separate entrance and exit, longitudinal seats at the ends and other changes recommended to make small one-man car better adapted to fairly heavy traffic lines.

Results of Safety Car Operation, J. C. Thirlwall. Elec. Ry. Jl., vol. 56, no. 14, Oct. 2, 1920, pp. 642–646, 8 figs. Experience of 38 companies. It is said that safety cars reduce injuries to passengers, provide safer, better paid and more interesting work for employees, and are popular with public.

Snow and Ice Loads on Trolley Wires. Formulæ for Ice-Covered Trolley Lines (Aneisungsformeln), Robert Edler. Schweiz. elektrotechnischer Verein Bul., vol. 11, no. 8, Aug. 1920, pp. 207–214, 3 figs. Results of calculation of additional load caused by snow and ice. (To be concluded.)

Switchboard Connections. Scheme for Investigating the Electrical Condition of one of the Lines in a Street Railway Network (Installation permettent de vérifier rapidement l'isolement des differentes lignes d'un réseau de tramways), E. Favereau. Revue générale de l'Électricité, vol. 7, no. 25, June 19, pp. 827–828, 2 figs. Suggests arrangement whereby voltmeter becomes connected to circuit when automatic circuit breaker opens.

STREETS

Cleaning. Contract Work vs. Municipal Forces in Street Cleaning. Eng. & Contracting, vol. 54, no. 14, Oct. 6, 1920, pp. 346–347. Study of method employed by various municipalities in street cleaning and in collection and disposal of municipal waste.

[See also SNOW REMOVAL.]

STRUCTURAL STEEL

Specifications. Specifications for Carbon Steel Bars, Blooms and Billets for other Purposes than Machine Tools (Cahier des charges pour la fourniture de barres, blooms, billettes et largets en aciers au carbone autres que les aciers à outils). Revue de Métallurgie, vol. 17, no. 7, July 1920, pp. 478–483. Specifications prepared by Commission Permanente de Standardisation.

Specifications for Low-Carbon Steel Bars, Blooms and Billets which are to be Later Casehardened and Tempered (Cahier des charges pour la fourniture de barres, blooms, billettes et largets en acier à faible teneur en carbone pour cémentation). Revue de Métallurgie, vol. 17, no. 7, July 1920, pp. 474–477. Specifications prepared by Commission Permanente de Standardisation.

Specifications for Non-Tempering Carbon Steel Bars, Blooms and Billets (Cahier des charges pour la fourniture de barres, blooms, billettes et largets en aciers au carbone non trempants). Revue de Métallurgie, vol. 17, no. 7, July 1920, pp. 469–473, 1 fig. Specifications prepared by Commission Permanente de Standardisation.

Standard Sections. Lists of British Standard Rolled Steel Sections for Structural Purposes.

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ENGINEERING INDEX (Continued)

British Eng. Standards Assn., no. 1, 1920, 19 pp. 6 figs. Standards adopted in July 1920.

SUBMARINE WARFARE

Detection of Submarines. Detection of Submarines Harvey C. Hayes. Proc. Am. Philosophical Soc., vol. 59, no. 1, 1920, pp. 1–47, 18 figs. Research and development work carried out by two groups of scientists, one group backed by private companies, the other by the U. S. Navy. Types of submarine detectors developed by England, France and United States.

SUBMARINES

German U-Boats. The Construction of U-Boats in the Germania Shipyard (Der Bau von Unterseebooten auf der Germaniawerft), H. Techel. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, nos. 35 and 37, Aug. 28 and Sept. 11, 1920, pp. 691–696 and 742–744, 27 figs. Notes on development of the switch gear and electric motors. Accumulator batteries; it is stated that, due to precautionary measures, no serious accidents through batteries occurred on German submarines. (Continuation of serial.)

Uses in Peace. Small Submarine for Oceanographic Work (Sur un petit sous-marin destiné aux travaux océanographiques), Maxime Laubeuf. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 10, Sept. 6, 1920, pp. 485–489. Suggests design.

[See also NAVIGATION, SUBMARINE, Navigational Obligations.]

SUBWAYS

Leipzig. Construction of the Underground Railway in the Vicinity of the Main Railroad Station at Leipzig (Die Untergrundbahn im Bereiche des Hauptbahnhofs Leipzig), H. Erler. Beton u. Eisen, vol. 19, nos. 1, 2–3, 6, 7–8, 9–10, 11 and 12–13, Jan. 8, Feb. 4, Apr. 8, May 4, June 5, July 5 and Aug. 5, 1920, pp. 1–5, 22–25, 67–68, 77–80, 97–99, 120–123 and 136–138, 66 figs. General description of completed section. Design and construction of the main building parts, including notes on excavation of tunnel, etc. The static calculation and constructive arrangement.

SUPERHEATERS

Steam Velocities in. Steam Velocities and Pressure Drop in Superheaters, H. B. Oatley. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 824–825. Advantages resulting from use of high steam velocities.

SWITCHBOARDS

See STREET RAILWAYS, Switchboard Connections.

T

TELEGRAPHY

Duplexing Submarine Cables. The Semi-Bridge System of Duplexing Submarine Telegraph Cables (Kajiura's System), J. Kajiura. Telegraph & Telephone Age, vol. 38, no. 19, Oct. 1, 1920, pp. 510–512, 2 figs. Japanese invention said to have proven successful in application to a number of submarine telegraph cables.

Rapid. Rapid Telegraphy (La télégraphie rapide), J.-B. Pomey. Électricien, vol. 51, no. 1258, Aug. 15, 1920, pp. 342–349, 7 figs. Comparison of Buckingham and Baudot apparatus.

Submarine-Cable. The Use of Alternating Currents for Submarine Cable Transmission, Frederick E. Pernot. Jl. Franklin Inst., vol. 190, no. 3, Sept. 1920, pp. 323–271, 14 figs. Results of experiments performed by members of Signal Corps Research Laboratory, Bureau of Standards, in attempt to develop method or methods of signal transmission over submarine cables which would permit of more effective use of existing cable systems. In method proposed and developed, signals are transmitted by means of alternating currents simultaneously with normal battery or direct-current operation of cable. Currents of several different frequencies may be used, reserving given frequency for each message, and by tuning or equivalent methods at receiving end these messages may be separated, so that simultaneous transmission of number of messages is rendered possible.

TERMINALS, RAILWAY

Design. Terminal Facilities, F. F. Gaines. Ry. Rev., vol. 67, no. 15, Oct. 9, 1920, pp. 546–548. Economics of location, design of shop structures, arrangement and equipment of departments, heating, lighting, ventilation and employees' convenience.

Standardization of Equipment. Saving Money and Time at Engine Terminals, H. L. Cornelison. Ry. Age, vol. 69, no. 12, Sept. 17, 1920, pp. 483–484, 3 figs. It is said that recent standardization of electrical distribution and equipment for both light and power at new engine terminals on Pennsylvania System has resulted in reduction of engineering and construction.

TESTING MACHINES

Repeated Stresses. Eden Foster Testing Machine for Repeated Stresses (La machine à essayer aux chocs répétés Eden Foster). Technique Automobile et Aérienne, vol. 10, no. 110, 1920, pp. 65–67, 5 figs. Machine is designed to operate without being fastened on solid foundation. Records of its operation are given, both when attached to foundation and when resting on ground.

TESTS AND TESTING

Notched-Bar Test Pieces. Report on British Standard Forms of Notched Bar Test Pieces. British Eng. Standards Assn., no. 131, 1920, 15 pp., 17 figs. Standards approved on July 15, 1920.

TIDAL POWER

Utilization of. Blue Coal (La houille bleue), R. Gouedard. Vie Technique & Industrielle, vol. 1, no. 12, Sept. 1920, pp. 483–488, 11 figs. Schemes which have been devised to utilize power to tides. Calculation of power available. (To be continued.)

TIN

Electrolytic Refining of. The Electrolytic Refining of Tin, Edward F. Kern. Gen'l Meeting of Am. Electrochem. Soc., Sept. 30–Oct. 2, 1920, paper no. 16, pp. 187–206, 2 figs. Conditions necessary for electrolytic refining of tin and for formation of solid adherent cathode deposits. Tests with various types of electrodes.

TIRES, RUBBER

Standards, British. British Standard List of Rubber Tyres for British Standard Rims. British Eng. Standards Assn., D. L. 8564, 1920, 22 pp., 22 figs. Specifications approved on April 14, 1920.

[See also MOTOR TRUCKS, Pneumatic Tires.

TRACTORS

Army Light Artillery. The New Army Light Artillery Tractor, G. R. Pennington and S. K. Wellman. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 321–328, 8 figs. Developed to replace six-horse teams which have been used to pull light artillery pieces such as 3-in. and 75-mm. field guns and their caissons. Overall length is $142^1/_2$ in. and overall width is 58 in. Engine used is White $4^1/_4$ in. by $5^1/_4$ in. truck model.

Drawbar-Pull. Tractor Drawbar-Pull, E. A. White. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 394 and 400. Table giving pull in pounds per ton required to move wagons over different surfaces. From Farm Implement News.

Four-Wheel-Drive vs. Caterpillar. Four-Wheel-Drive vs. Caterpillar Tractor, E. R. Greer. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, pp. 385–387 and (discussion) pp. 387–389, 5 figs. Based on experience of U. S. Army. It is claimed that lighter weight is possible with four-wheel-drive construction than with either caterpillar or rear drive.

Rating of. Rating Tractors on Piston Displacement. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, p. 334. Possibility of drawing up formula to compare different tractor engines. Reference is made to results obtained in tests conducted at Central States Tractor Demonstration at Evansville, Ind., in Oct. 1919, and Ohio State University tractor tests, Jan. 1920.

Weight-to-Pull Ratio. Relation of Tractor Weight to Pull. Jl. Soc. Automotive Engrs., vol. 7, no. 4, Oct. 1920, p. 329. Percentage of total weight delivered in drawbar-pull under various conditions, as determined in tractor trials carried out at Lincoln, England. From Farm Implement News.

TRANSFORMERS

Overvoltages. Overvoltages Produced by Third Harmonics of Saturation in Three-Phase Transformers (Sur les surtensions créées par les harmoniques 3 de saturation des transformateurs triphasés), M. Swyngedauw. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 8, Aug. 23, 1920, pp. 430–433. Calculation of possible maximum overvoltage.

Resonance of Third Harmonics Produced in Transformers by Hysteresis and Saturation of Iron (Résonance des harmoniques 3 engendrés par l'hystérésis et le saturation du fer dans les transformateurs), R. Swyngedauw. Revue générale de l'Électricité, vol. 8, nos. 10 and 12, Sept. 4 and 18, 1920, pp. 299–312, 9 figs., and 363–373, 4 figs. Influence exerted by iron of transformer upon value of amplitude of third harmonic of secondary tension is studied, and a method evolved for computing this amplitude. Formula is developed by mathematical reasoning, and experiments are related which verified analytical conclusions.

Power for Given Installation. Power of Transformers for an Installation Comprising Induction Motors (Note sur la puissance des transformateurs et leurs connexions dans les installations comprenant des moteurs d'induction), G.-P. Roux. Revue générale de l'Électricité, vol. 7, no. 25, June 19, 1920, pp. 823–827, 6 figs. Method of calculating power transformer is required to possess is explained and its application to numerical examples illustrated.

TRANSPORTATION

Economics. Freight Rates and the Marine Terminal Problem. Freight Handling & Terminal Eng., vol. 6, no. 9, Sept. 1920, pp. 328–332. Economics of transportation. Presidential address before Soc. Terminal Engrs.

Freight, Container System. The Container System of Freight Transportation. Ry. Age, vol. 69, no. 13, Sept. 24, 1920, pp. 515–517, 3 figs. Container is designed so that merchandise may be placed in it at manufacturing plant or in warehouse, container locked and sealed, and then transported by motor truck to railroad, or to waterway, where container and its contents are transferred to flat car, or to boat, without rehandling materials.

Types of Vehicles. The Bus, the Trackless Trolley or the Trolley Car for Light Traction—Which? L. M. Aspinwall. Elec. Jl., vol. 17, no. 10, Oct. 1920, pp. 443–445. Suggests that special features of design of each of these types should not be considered as inherent to it, but that they be used in designing new types possessing such of these features as are needed for the kind of service it is required to perform.

Water, Economy of. The Economy of Water Transportation, Secor Cunningham, Jr. Int. Mar. Eng., vol. 25, no. 10, Oct. 1920, pp. 843–845. Economical conditions are pointed out and construction of project for operation of Illinois River and connecting canals is urged.

TWIST DRILLS

Sharpening and Thinning Machine. Twist-Drill Sharpening and Thinning Machine. Engr. vol. 130, no. 3375, Sept. 3, 1920, pp. 237, 3 figs. Built by Herbert Hunt & Sons, Manchester, England. Machine is said to give accurate and uniform results in hands of unskilled operator.

TYPEWRITERS

Manufacture of. Operations in the Manufacture of Typewriters—IV. Machy. (Lond.), vol. 16, no. 417, Sept. 23, 1920, pp. 770–775, 14 figs. Description of methods used by Imperial Typewriter Co., Ltd., Leicester.

U

URANIUM STEEL

Composition of. Uranium Steels (Les aciers à l'uranium), E. Polushkin. Revue de Métallurgie, vol. 17, no. 6, June 1920, pp. 421–437, 16 figs. Results of experiments and photomicrographs. It was found that uranium does not change position of Ac_1 excepting when uranium content is over 7 per cent. Uranium did not affect resistance to shock or resistance to alternate tensions.

V

VACUUM TUBES

Audio-Frequency Generators. An Audio-Frequency Vacuum-Tube Generator, J. A. Eyster. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 10, Oct. 1920, pp. 888–889, 3 figs. Use of three-element vacuum tube for supplying alternating current to conductivity bridge is described and illustrated. Its advantages are set forth and procedure which was followed in construction of such generator described.

VALUATION

See APPRAISAL.

VENTURI METERS

Test Curves of. Test Curves of Special Ventur Meter Agree with Theory, W. S. Pardoe. Eng. News-Rec., vol. 85, no. 13, Sept. 23, 1920, p. 589, 1 fig. Constructed from results obtained at University of Pennsylvania.

VIBRATIONS

Measurement of. New Optical or Electric Apparatus for Measuring Angular Vibrations (Nouvel appareil optique ou électrique pour le mesure des oscillations de vitesse et des écarts angulaires), A. Blondel. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 6, Aug. 9, 1920, pp. 329–335, 3 figs. Apparatus for measuring vibrations of high speed electrical machines. Records of vibrations may be obtained either on a photographic plate by a ray of light emitted from point in vibrating system, or on paper band by perforations produced by electric spark.

Recording Apparatus. New Optical or Electrical Apparatus for Recording and Measuring Vibrations of Rotating Machines (Nouvel appareil optique ou électrique pour l'entrique pour l'enregistrement et la mesure des oscillations de vitesse et des écarts angulaires), A. Blondel. Technique Moderne, vol. 12, no. 8, Aug. 1920, pp. 323–332, 14 figs. Applications to measurement of periodic vibrations, of slow vibrations of large amplitude, and of vibrations of synchronized machines. (Concluded.)

W

WALLS

Hollow-Brick Masonry Construction. The Schnell Construction System (Bauweise "Schnell"). Beton u. Eisen, vol. 19, nos. 11 and 12–13, July 5 and Aug. 5, 1920, pp. 118–120 and 138–141, 9 figs. Results of strength and heat-transmission test of a wall constructed according to the Schnell system (known in Germany as the Ambi-Massive construction system), carried out at the Material Testing Station of Vienna High School and demonstrating the superiority of this over other tested hollow brick masonry types.

Tests. Results of Additional Distortion Tests on Various Types of Wall Construction. Am. Architect, vol. 118, no. 2336, Sept. 29, 1920, pp. 413–415, 4 figs. Report of testing engineers, Armour Inst. of Technology, giving results of distortion tests conducted in that Institute's laboratory on four different types of exterior wall construction.

WARSHIPS

Remodeling of. The Remodeling of Warships into Cargo Ships (Umbau von Kriegsschiffen zu Handelsschiffen), H. Ahnhudt. Schiffbau, vol. 21, no. 40, Aug. 25, 1920, pp. 1083–1090. Result of investigation shows that, in general, remodeling from economic standpoint is equal in value to new construction when its cost is about half that of new construction; it is to be recommended in Germany because of shortage of building material and because time required for reconstruction is about half that for new construction.